RESTRICTED

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INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

INTERNATIONAL DEVELOPMENT ASSOCIATION

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# APPRAISAL OF

# YONG SAN GANG IRRIGATION PROJECT - STAGE I

# KOREA

December 21, 1971

Agriculture Projects Department

## Currency Equivalents

Except where otherwise stated all figures are quoted in U.S. dollars (US$). The Project cost estimate is shown in both US$ and Korean (W) of 1971.

| | | |
|---|---|---|
| US$1 | = | 370 Won |
| 1 Won | = | US$0.00270 |
| Won Million | = | US$2,700 |

## Weights and Measures

| | | |
|---|---|---|
| 1 kilometer (km) | = | 0.62 miles |
| 1 millimeter (mm) | = | 0.039 inch |
| 1 meter (m) | = | 3.28 feet |
| 1 hectare (ha) | = | 10,000 square meters = 2.47 acres |
| 1 square kilometer ($km^2$) | = | 100 ha = 0.386 sq miles |
| 1 cubic meter ($m^3$) | = | 1.31 cubic yards |
| 1 million cubic meters ($Mm^3$) | = | 810 acre feet |
| 1 metric ton (ton) | = | 2,205 lb |
| 1 kilogram (kg) | = | 2.2 lb |
| 1 ton rice (Paddy) | = | 650 kg rice (white) |

## Principal Abbreviations and Acronyms Used

| | | |
|---|---|---|
| LIA | - | Land Improvement Association |
| MAF | - | Ministry of Agriculture and Forestry |
| NACF | - | National Agricultural Cooperative Federation |
| ORD | - | Office of Rural Development |
| SPAD | - | Special Projects Administration Department |
| ULIA | - | Union of Land Improvement Associations |
| ADC | - | Agricultural Development Corporation |

## Fiscal Year

January 1 - December 31

KOREA

# AN APPRAISAL OF THE YONG SAN GANG IRRIGATION PROJECT - STAGE I

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This report is based on the findings of an appraisal mission which consisted of Messrs. A. Golan, H.T. Chang, B. Kanchanalak, W.A. Lucas (Bank/IDA), and S. Okabe (Consultant).

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

SUMMARY AND CONCLUSIONS

i. This report appraises a project for irrigation development in the Yong San Gang Basin, for which Bank/IDA assistance of US$48 million is proposed. The project is part of the All Weather Farming Program initiated within the framework of the Second Five-Year Economic Development Plan, 1967-71. The long-term goal of this program is to provide irrigation to more than 500,000 ha of paddy fields and upland areas, as a major effort to increase the production of food. In 1969 the Bank extended a US$45 million loan (600-KO) to assist the Government in implementing the Pyongtaek-Kumgang Irrigation Project which is an important part of the program. This project is making satisfactory progress at present following an initial delay of one year due to a reorganization of the Government agency charged with implementation of the project.

ii. The rapid growth of the industrial sector in Korea during the past several years has been accompanied by a much lower rate of increase in agricultural production. This has been due, in part, to the limited area of arable land in the country and the population drain from rural to urban areas. There was also insufficient support on the part of the Government for agricultural programs. These factors, combined with increased consumption by the urban population, brought about a significant increase in the food deficit, especially in foodgrains and made it necessary to import large quantities of food with scarce foreign exchange. Severe drought in 1967/68 once again confirmed the need for irrigation development, specifically in the southwest provinces, to maintain adequate levels of production. The Third Five-Year Economic Development plan (1972-76) provides increased resources for agricultural and irrigation development.

iii. The proposed Yong San Gang Irrigation Project has been planned to provide irrigation to 33,000 ha in an area that has one of the highest potentials for production in the country. A supplemental irrigation supply would be provided for 12,500 ha, which are partially irrigated at present, and a full supply to 20,500 ha, which are now farmed under rainfed conditions. The climate, soil, available water resources and the level of competence of the farmers are all favorable to increasing production. The project would consist of dams and reservoirs, irrigation and drainage systems, land consolidation and on-farm development, and roads in each of four subprojects located in the upper central part of the Yong San Gang Basin in Jeonla Nam Do, one of the southwest provinces. The project would also include supporting agricultural services for extension, research and agricultural inputs and training of Government staff.

iv. Estimated total project cost is US$85.2 million, with an estimated foreign exchange component of US$44.6 million, or 52% of the total. Bank/IDA financing of US$48.0 million would consist of a US$33 million Bank loan, which includes US$3.4 million for interest during construction on the loan,

and a US$15 million IDA credit. Project works would be constructed by contract following international competitive bidding, and local contractors are expected to be successful bidders on most of the work. The foreign exchange component for civil works would be about US$30 million. It is estimated that about US$13.0 million in foreign exchange would be required for direct purchase of equipment, materials and supplies and for foreign consultants. With the exception of consultants, all these items would be procured through international competition. Should local manufacturers be the successful bidders on all supply contracts, up to US$2 million of local currency financing might be involved.

v. Overall responsibility for implementing the project would rest with the Agricultural Development Corporation (ADC), which presently performs rural development work of this nature in the country. Following completion of the project, the ADC would operate and maintain the dams and main irrigation and drainage systems while the Land Improvement Associations (LIA's), who presently manage the small partially irrigated areas, would retain responsibility to manage and maintain the systems at the farm level. These LIA's would be expanded or increased in number to correspond to the overall project area. A coordinating committee, with representatives from relevant Government Ministries or Agencies, would exercise overall supervision of the project.

vi. At full agricultural development in 1982, the net value of production is expected to be around US$20.3 million compared with a level of US$3.8 million, which can be expected without the project. Most of the increase would be from higher yields, more double cropping and the introduction of high value crops, all made possible by irrigation. It has been estimated that an increase of 35% in labor inputs over the current level would be required to obtain this increase in production. Because of the labor shortage in the area, this increase would be met by increased farm mechanization. The economic rate of return of the project would be about 13% and the net present worth of foreign exchange benefits, using a 12% discount rate, would be US$44.8 million. A sensitivity analysis indicates that under a number of adverse conditions this rate would not be less than 10%. The project would benefit some 45,000 farm families and it is estimated that their per capita income would increase from US$85 at present to US$180 by 1982. Such an increase would prevent a further widening in the income gap between the beneficiaries and the rest of the economy although it would still leave them below the national average, which is US$235 at present and estimated to exceed US$400 by 1982.

vii. The project is suitable for a Bank loan of US$33 million for a period of 30 years, including a six-year grace period, and an IDA credit of US$15 million. The Bank loan would be made to ADC, with the Government of the Republic of Korea as guarantor, and the IDA credit to the Government.

KOREA

# YONG SAN GANG IRRIGATION PROJECT - STAGE I

## I. INTRODUCTION

1.01 The Government of the Republic of Korea has requested Bank/IDA assistance in financing construction of Stage I of the Yong San Gang Irrigation Project in the north central part of Jeonla Nam Do Province. This would be the second Bank loan to Korea for irrigation development, the first one being a US$45 million loan (600-KO) signed in May 1969 to assist in financing the Pyongtaek-Kumgang Irrigation Project. Commencement of work under this loan was delayed by one year due to a major reorganization whereby the agency responsible for the project, the union of Land Improvement Association (ULIA) was consolidated into the newly created Agricultural Development Corporation (ADC), the agency presently responsible for the project. Performance has since improved and the present rate of progress is satisfactory. In the agricultural sector Korea obtained an IDA credit in 1971 (234-KO) of US$7 million for livestock development and a project is currently being prepared for a loan from the Bank for an agricultural credit program to assist small farmers in modernizing their operations.

1.02 The proposed project is part of a master plan for eventual irrigation of about 100,000 ha in the Yong San Gang Basin and on tidal lands along the west and south coast of the province. It would consist of dams and reservoirs, irrigation and drainage systems, land consolidation and on-farm development, and roads to serve an overall area of about 33,000 ha. It would provide supplementary irrigation to 12,500 ha, which now receive only partial irrigation, and a full supply to 20,500 ha, which are currently farmed under rainfed conditions. The project would also include supporting agricultural services for extension, research, agricultural inputs, storage, marketing, credit and training.

1.03 Due to a series of severe droughts in the south-western part of Korea, the Government began giving serious attention about five years ago to irrigation development in that region. Surveys, studies and planning in the Yong San Gang area were carried out by ULIA with help from the FAO/IBRD Cooperative Program and in November 1969 a Bank mission visited Korea to appraise the project. The mission found, however, that the project needed additional studies on the hydrological aspects and further refinement of the plan. Additional assistance was provided by an appraisal follow-up in February 1970 and again in January 1971. In the meantime, ADC contracted for the services of Sanyu Consultants International, of Japan, and in May 1971 a basin wide master plan and a feasibility study for a first stage project were completed. This forms the basis for the appraisal covered by this report.

1.04 This report is based on the findings of a mission that visited Korea in May 1971, comprising of Messrs. A. Golan, H. T. Chang, B. Kanchanalak and W. A. Lucas (Bank/IDA) and S. Okabe (consultant).

## II. BACKGROUND

2.01 With a total land area of 98,000 $km^2$ and a population of about 31.8 million in 1970, Korea has a fairly high density of 320 inhabitants/$km^2$. In the past decade, family planning has been emphasized and the population growth rate has dropped to an average annual rate of 2.3% for the period 1965-70. Government expects a further reduction to 1.5% per annum by 1976. During 1960-69, unemployment was reduced from 8% to 5%.

2.02 Korea's economy has shifted in the past 10 years from its predominantly agriculture base to one that is semi-industrial. During 1960-69 the agricultural sector's rate of growth increased only slightly under 4% annually as compared with an overall economic growth rate of 11% per year during the same period. As a result, agriculture's share in total GNP declined from 39% in 1965 to 26% by 1970, while its share of laborers in the total work force decreased to 49.5%. In the process, the gap between urban and rural incomes widened and reliance on imported foodgrains increased. Furthermore, the rapid industrial growth has led to a migration of labor from the farms to the city, thereby bringing about acute labor shortages during peak agricultural activities and a substantial rise in rural wages. In an effort to narrow the income gap and reduce the foodgrain deficit, Government adopted a high rice price policy, which was designed to meet these specific objectives but carried a high budgetary cost (para 6.07).

2.03 Because of unsatisfactory development during the sixties, Government has given high priority to improvement of agriculture, including an expansion of output of major crops and promoting higher living standards in rural areas, during the Third Plan period. The strategy adopted to achieve this improvement and development is comprehensive in its coverage of the forestry, fisheries, livestock and farming sectors. For the farming sector it would consist of improved cultural practices; increased use of modern inputs, including fertilizers, lime, pesticides and machinery; better seeds and improved varieties; land consolidation and on-farm development, especially an increase in rearrangement of rice lands with irrigation and drainage in the main river basins; improved infrastructure, mainly roads; improved control and management of water resources; continued development of upland areas and small watersheds; expanded credit to farmers to support on-farm development as well as production; continuation of the price support policy on foodgrains as an incentive to higher production; and strengthening the cooperative program, particularly for improvement of storage and marketing facilities. It is expected that the plan, during the five year period, would reduce the food deficit in the country, improve the balance of payment situation and reduce the income disparity between the urban and rural population. One important element in the plan is to continue the 10-year integrated development plan in the four major river basins, initiated during the Second Five-Year Plan, which envisages extensive irrigation and drainage facilities. The Yong San Gang project, the first stage for development of this basin, would be a further advance of this plan and would make a significant contribution to the overall agricultural development strategy.

## III. THE PROJECT AREA

### General

3.01 The project area is located in the Yong San Gang Basin in Jeonla Nam Do Province in the extreme south-western part of the Republic of Korea (see map). The Yong San River has a drainage area of 2,800 km$^2$, not including the estuary at Mok Po, and flows generally north-east to south-west for about 80 km. There are three large tributaries -- the Hwang Yong on the west and the Kwang Ju and Ji Seok Cheon on the east -- which empty into the river in the project area. Project lands would be located in the valleys along the Yong San River and its main tributaries in the upper and middle part of the basin, below the mountains and upstream from the tidal estuary.

3.02 Project lands are divided into four independent subprojects corresponding to the river or tributary from which they would derive their irrigation supply (Annex 1). Each of these subprojects, in turn, is made up of one or two irrigation zones (see map).

### Climate

3.03 The southern location of the project area and the influence of the ocean on two sides tend to moderate the extremes of climate found in other parts of Korea. The length and severity of the winter season is reduced and the summer growing season is extended, which improves conditions for double cropping and permits a greater diversification to crops such as vegetables and fruits. The average annual rainfall is about 1,250 mm, about 85% occuring in the summer season (April to September). Temperatures range from a maximum of 31°C during July-August to below freezing in the winter, when snow to a depth of 30 cm has been recorded.

3.04 While the climate is generally favorable for agriculture, there is a serious constraint in the recurring drought that may occur for periods of two to three weeks during the rice growing season, June-September, and occasionally in late May-early June during the nursery and transplanting period. These yearly droughts also have a serious effect on upland crops, particularly during the maturing period in August and September. In addition, there is an occasional drought year, such as 1967/68, when the dry period is prolonged for several months. Such conditions pose a severe risk to agriculture, which irrigation would overcome.

3.05 Two additional constraints to agricultural production are the heavy downpours in early spring, which may damage the winter barley crop, and typhoons in August and September. Flooding of lowlands in the project area, which occurs during these periods, would be greatly alleviated by construction of the on-farm and main drainage systems.

## Soils, Topography and Drainage

3.06 Two distinct soil groups can be found in the project area (Annex 1). The main group, accounting for about 73% of the net irrigable area of 33,000 ha, is the comparatively flat low-lying paddy land consisting of loam or silt loam down to a depth of 1 m or more and with slopes of less than 10%. Soils in the other group, which are found mainly in the surrounding upland, consist of silt loam, silty clay loam or clay loam. They vary in depth between 0.7 and 1.0 m and have slopes up to 35%. Upland areas that are too steep and above 60 m in elevation were excluded from the project. In both groups, clay content tends to increase moderately with depth, but in neither case can the soils be considered heavy. Internal drainage, however, is slow due to the fairly high silt content of almost all soils. It ranges from good in the uplands to fair in the lowlands and there is no serious problem of waterlogging because of a high groundwater table.

3.07 Like most other soils in the southern part of Korea that are derived from granite rocks, all project soils are highly acidic. Field tests show 85% to have a pH value below 6 and 65% below 5.5. Government has been providing agricultural lime on a subsidized basis throughout the country for a number of years and its use is already a common practice in the project area. Because of an inadequate supply at present, however, the application rates are low.

3.08 Natural surface drainage in the project area is good due to the generally undulating character of the land and the well defined drainage system. The main rivers, with numerous large and small tributaries, provide adequate watercourses to remove surplus runoff. At present time both the low land and upland soils support a relatively high production, mainly rice and barley, and are capable of even higher production with full irrigation and adequate inputs such as lime and fertilizers.

## Farm Size and Land Tenure

3.09 About 45,000 families, averaging six members per family, for a total farm population of 270,000, would participate in the project. Most farms are small, the majority being in the 0.5 to 2.0 ha range. In addition, most holdings are fragmented and the fields generally have an irregular shape. A breakdown of farm holdings by size is presented below:

| Farm Size | Farm Holdings | | Farming Area | |
|---|---|---|---|---|
| ha | No. | % | Ha. | % |
| Up to 0.3 | 9,000 | 20 | 1,300 | 4 |
| 0.3-0.5 | 8,500 | 19 | 3,000 | 9 |
| 0.5-1.0 | 14,000 | 31 | 8,600 | 26 |
| 1.0-2.0 | 10,300 | 23 | 12,200 | 37 |
| 2.0-3.0 | 2,300 | 5 | 4,600 | 14 |
| 3.0 and over | 900 | 2 | 3,300 | 10 |
| Total: | 45,000 | 100 | 33,000 | 100 |

3.10 Implementation of the Land Reform Law began in 1958, and today most farms in the country, as well as the project area, are owner-operated. Land tenure is not a constraint to agricultural development.

Agriculture

3.11 The project area is characterized by a traditional rice-barley monoculture. Together, these two crops account for over 85% of the cropped area and total value of production. Over half of the rice area receives partial irrigation either from small tanks or the main rivers, but the water supply is unreliable and there are great variations in the cropped area from year to year. Present rice yields 1/ of 2.8 ton/ha under partial irrigation and 2.4 ton/ha under rainfed conditions are among the highest in developing countries but still considerably below the potential.

3.12 Despite the acute labor shortage during peak periods, the decline in farm laborers and the sharp increase in farm wages during recent years, little has been done toward mechanizing farm activities which are still carried out almost entirely by buffalo and hand. The main reason for this is the absence of adequate farm roads and drainage facilities, which would permit the drying out of fields in time for the winter crop cultivation, although a shortage of power tillers in the country and inadequate institutional credit resources have also played a role.

3.13 Agricultural credit and farm inputs are available through the semi-autonomous National Agriculture Cooperative Federation (NACF) and its member cooperatives, which operate crop and farm input storage facilities. Its credit resources are inadequate, however, to meet all the farmers' demand, and over half of the farm credit requirements are provided by private money lenders at high interest rates. Extension services are provided by the Office of Rural Development (ORD) of the Ministry of Agriculture and Forestry (MAF) and it also operates experimental stations and demonstration plots. The Land Improvement Associations (LIA), which own, operate and maintain the existing irrigation systems in the area, hire additional extension workers to serve their members. Although the overall level of extension service is satisfactory, little work is done at present on irrigated crops other than rice.

Transportation

3.14 The project area has highway, railway and airline connections north to Seoul, which provide a good outlet for agricultural products to the main market and distribution center for the rest of the country. The railway is serving as the primary carrier at present. Government plans to improve the highway facilities in the next two years by constructing a paved road from Pusan to Kwang Ju and thence north to Chonju, connecting with the

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1/ All rice yields in this report are expressed as white rice.

existing paved highway to Seoul and also with the recently completed Seoul-Pusan highway. This construction program would be partially financed under a Bank loan (769-KO). With the completion of these roads in 1974 the project area would be within easy reach of Seoul (346 km) and Pusan (265 km), the two largest cities in the country.

3.15 All of the cities and towns within the project area are interconnected by good all-weather gravel-based highways. These provide access to most of the area but there is a need to improve the secondary and farm service roads which directly serve the farms as many of these are not suited to motorized equipment, especially during the wet season.

## IV. THE PROJECT

### Description

4.01 The Yong San Gang Irrigation Project represents the first stage of a basin development plan that envisages eventual development and reclamation of 100,000 ha in Jeonla Nam Do Province. The plan was prepared through a computerized systems analysis of individual sub-basins in the Yong San Gang drainage basin and the tidal areas along the west and south coast of the province. The Stage I project was then selected as the first step in developing the basin on the basis of studies which proved that development of the upper valley lands and adjacent uplands, with reservoirs in the upper watershed, was more advantageous at this time than the more costly and time consuming construction of seadikes and reclaiming of tidal lands (Annex 2). The project would consist of four independent subprojects, each with its own storage dam and irrigation and drainage network. The works to be implemented under the project are summarized below and also described in more detail in Annex 2. Project works in each of the four subprojects would include:

(a) dam and reservoir for storage and regulation on the main river;

(b) a main canal and lateral system to serve the irrigable area;

(c) land consolidation and on-farm development (totalling 30,000 ha in all the subprojects);

(d) a main drainage system;

(e) relocation of existing roads in the reservoir area and improvement of secondary and farm service roads in the project area; and

(f) a primary lime application on all lands following on-farm development.

In addition, the project would provide for the preparation of a feasibility study for a second stage project in the basin. A firm of consultants would assist ADC in carrying out this study as well as with final designs and implementation of the project. The project would also include supporting agricultural services for extension, research, provision of credit for seeds, fertilizers, lime, machinery and other inputs; and in-service and overseas training of ADC staff in the major disciplines relevant to implementation and management of the project. Construction work on the project would begin late in 1972 and be completed by the end of 1976. A proposed construction schedule is presented in Annex 3.

Project Works

4.02 Dams. Three of the dams are earth fill and one is rock fill. Conditions for construction are good and no difficulties are expected in carrying out this part of the project. Construction of the dams would include spillways and outlet works, relocation of roads in the reservoir area and the acquisition and clearing of land in the reservoir area.

4.03 Main Canal and Lateral System. The four main canal systems, which include secondary laterals, would receive their supply directly from the dams, and delivery to the irrigated area would be by gravity. No pumps or diversions in addition to those presently in operation would be required. Canals and laterals would not require lining except in a few permeable sections. A large number of tunnels, flumes, siphons and overflow structures would be required due to the undulating topography and the intensive pattern of cross drainage.

4.04 Drainage System. The main drainage system, together with the tertiary drains, are for the primary purpose of removing excess surface water. The systems would be designed and constructed for drainage of both lowland and upland under conditions of maximum rainfall. In the case of rice land, another important function would be to dry up the land following the rice harvest in order to plant the winter crop as early as possible.

4.05 Land Consolidation and On-Farm Development. To permit design of an efficient system, farm holdings, which are presently fragmented and irregular in size, would be consolidated and arranged into uniform tracts of about 0.3 to 0.5 ha in size. The land consolidation would involve rearrangement of holdings with only minor exchanges of land between owners. It would be combined with leveling and bordering of the fields; construction of tertiary irrigation and drainage canals, structures and service roads; and lime application. This integrated procedure, which conforms to standards developed over the years in Korea, produces a uniform rectangular layout of the farms and the irrigation system, which is more efficient for both the farming and irrigation operations. The full operation as described above which has already been completed on 3,000 ha (Annex 2), would be applied to about 18,500 ha of paddy land. A modified treatment, would be applied to an additional 11,500 ha of upland. This would differ primarily in the amount of leveling and the use of terraces. Irrigation, drainage and improved roads would be provided to all land in the project. In the upland

portions of the project area, on-farm development would include clearing and terracing of about 2,200 ha of land presently in natural forest. With over two-thirds of the farmers in the area already having agreed to participate in the project, consolidation would be mandatory.

4.06 Roads. Farm service roads to individual tracts would be constructed as part of the on-farm development. The secondary system connecting the farm roads to the main highways would be extended and improved as part of the main canal and secondary lateral system. Altogether this would provide an adequate system for the movement of agricultural production and services. The standard layout for on-farm development specifies a 6-m wide roadway (5 m gravel surfaced) along the lateral supply canals and a 4-m wide road (3 m gravel surfaced) along one bank of tertiary canals. The 6-m width appears suitable for the lateral roads since they would be the main outlet to the highway for a large group of farms. The 4-m width for the tertiary roads, however, appears excessive since they would normally serve less than 40 tracts, or 16 ha, and need only to accommodate single lane traffic of small equipment such as power tillers and carts. Specifications would be reviewed by ADC and the consultants to determine if a narrower road would serve project needs as well (para 4.15).

4.07 Lime Application. A primary application of lime, following the land leveling and construction of borders, would be included as part of the initial project implementation to reduce the soil acidity and assist farmers in reestablishing full production on the newly developed lands.

Water Supply, Demand, Quality and Rights

Rainfall. Rainfall in the project area is irregular and ill-timed to support maximum production from agriculture. Drought periods ranging from three weeks to two months occur during the early growing season in May-June and the maturing period in August-September. Records for the past 53 years reveal that in 50 of those years there was at least one month during the critical growth period for rice in which effective rainfall accounted for less than half of the crop water requirement. Although somewhat less severe in the case of upland crops, here too the deficiencies during the same period were quite frequent with 33 years of shortage (equivalent to three years out of five) in the case of winter upland and 39 years (equivalent to seven years out of ten) for summer upland (Annex 4). Shortages of this magnitude create serious risks to agriculture and are the major factor in limiting yields and diversification to higher value crops. The main justification for irrigation in the area is to provide water during these frequent drought periods, such that greater production would be possible.

4.09 Water Supply. The main water supply for the project would be obtained through storage and regulation reservoirs on the main rivers in each of the four subprojects. The available runoff in these rivers was estimated on the basis of four years of rainfall and discharge records in each basin and the reconstituted flow for the 30-year period, 1940-69, by correlation with existing records for this period at Kwang Ju for rainfall and the Yong San Gang River for discharge. The average annual inflow into all the reservoirs is estimated as 200 $Mm^3$. An additional supply to the project,

specifically to the presently irrigated area, would be available from small tanks or reservoirs within the project area and direct diversions or pumping from the rivers. The latter supply would be obtained mostly from the unregulated flow of tributaries entering the main rivers downstream from the reservoir sites. However, some release from the reservoirs would be required during the low flow period each year to supplement the supply to these lands. The annual average of this additional supply is estimated as 110 $Mm^3$.

4.10 Demand. Total crop water requirements for the 33,000 ha in the project were estimated on the basis of double cropping with rice and upland crops and a cropping intensity of 182%. Average annual requirements would vary from 7,000 $m^3$/ha for two upland crops to 10,000 $m^3$/ha for double cropping with rice. The total average annual requirement for the project would be approximately 300 $Mm^3$, which includes 4 $Mm^3$ for municipal and industrial supply for the main urban centers in the project area. Taking into account effective rainfall and conveyance and farm efficiencies, the net diversion demand would be about 260 $Mm^3$.

4.11 Reservoir operation studies for each of the four reservoirs proposed for the project indicate that the project requirements would be met in 26 years out of 30. In the case of the severe drought years deficits in crop water requirements on the order of 15 to 20% and up to 30% would occur. The magnitude of these deficits has been taken into consideration in projecting average future yields on the project. The capacity of the reservoirs has been established on the basis of using about 80% of the inflow and utilizing holdover storage within reasonable limits (three to four years) to cover the deficit periods. The extreme variations of inflow from an average to a drought year makes it uneconomic to construct dams and reservoirs large enough to store 100% of inflow and to hold the surplus over for more than five years.

4.12 The reservoir operation studies indicated further that Dam Yang Reservoir could not adequately supply all the irrigable area commanded in this subproject, whereas Jang Seong has the capability, with an increased reservoir capacity, to serve more than originally planned. It has been proposed, therefore, that the two systems be linked together so that integrated operation would be possible. This modification in the project plan would provide an adequate water supply from the reservoirs and other sources for the project area. The link canal would be 10 km long, including a 5-km tunnel. The adjustments for optimum size of the two dams and reservoirs would be made in the final design of these structures.

4.13 Quality. The quality of water in the rivers that would supply the project is excellent for agricultural purposes. Sample tests show that salinity and sodium and boron content are within safe limits. Further details of present water supply, demand and quality are presented in Annex 4.

4.14 Water Rights. The basic law controlling the use of water from rivers and streams in Korea is known as the "River Law" (Law No. 892, 1961). Under it, a right to use water for agricultural purposes may be acquired and retained on the principle of beneficial use, with a priority on the basis of first in use-first in right. This applies to all lands in a river basin since the prior right of riparian lands is not recognized by Government.

All existing rights on project lands would, therefore, be sustained and new lands would acquire the necessary right. Construction of the reservoirs would not prejudice downstream rights outside the project area. Assurances were obtained from Government that the water right of all lands under the project would be legally recorded and the normal and regulated flow of the rivers protected from future depletions that could adversely affect the supply to the project.

Engineering Design

4.15 Preliminary designs and cost estimates based on field surveys have been completed by ADC for the dams and irrigation and drainage systems. Project works would be conventional and the data and criteria used for the feasibility report would be adequate for final designs. Overall layout of the project and the designation of irrigable areas have been completed on a 1:3,000-scale map with 1-meter contours, prepared from controlled aerial photos. This map, also showing existing farm boundaries, roads, villages and other features, is adequate for preparing the final plan. Planning and estimates for land consolidation and on-farm development are based on standard layouts for various types of treatment. Detailed field surveys would be required to establish the new tract boundaries, elevations for land leveling and alignment of canals and roads within the farming area. During the final design phase, ADC, together with its consultants, would review the criteria for farm service roads, the optimum height of Jang Seong and Dam Yang dams and the design criteria for the link canal. Assurances were obtained that ADC would carry out these reviews and submit its findings to the Bank/IDA for comment within nine months after signing of the loan/credit agreement.

4.16 ADC is responsible for obtaining rights of way. In the past, however, it has encountered some difficulties in acquiring land from farmers, with consequent delays in construction. Therefore, to expedite such procedures under the project, all such activities would be carried out by the Provincial Government, with ADC paying all costs, plus a 5% commission to the Provincial Government to cover administrative expenses. This arrangement worked well on the Pyongtaek-Kumgang project and it should be adequate for the present project.

Cost Estimates

4.17 Unit prices presented in the feasibility study were updated on the basis of tendering results on the Pyongtaek-Kumgang Irrigation Project (Loan 600-KO) and more recent information available in Korea to bring them in line with expected price levels at the end of 1971.

4.18 The project cost estimates of US$85.2 million include provision for engineering, administration, consulting services, and the preparation of feasibility studies for Stage II of the project. Since ADC is exempted from paying import duties, the estimates are net of all such duties. About 25% contingencies have been included in the estimates. They consist of technical contingencies of 20% on the dams and link canal, 15% on the main canals and

10% on all other items; and a contingency for price increases based on a cumulative 5% per-year for foreign expenditures and 6% per-year on local currency expenditures. These technical contingencies reflect conditions in the area and the advanced stage of investigations and design. The cost estimates presented in the feasibility study are considered reliable. The contingencies for price increases are based on experience in recent years on cost increases for labor, materials and supplies in the country and for goods imported, mainly from the USA and Japan.

4.19 A breakdown of project costs is presented in Annex 5 and summarized in the table below.

| | (W Million) | | | (US$ Million) | | | % Foreign Exchange |
|---|---|---|---|---|---|---|---|
| | Local | Foreign | Total | Local | Foreign | Total | |
| Dams | 1,739 | 3,108 | 4,847 | 4.7 | 8.4 | 13.1 | 64 |
| Main Canals and Laterals | 2,442 | 3,774 | 6,216 | 6.6 | 10.2 | 16.8 | 61 |
| Main Drainage Systems | 666 | 592 | 1,258 | 1.8 | 1.6 | 3.4 | 47 |
| Land Consolidation and On-Farm Development | 2,923 | 3,182 | 6,105 | 7.9 | 8.6 | 16.5 | 52 |
| Lime Application | 222 | - | 222 | 0.6 | - | 0.6 | 0 |
| Acquisition of Right of Way | 2,257 | - | 2,257 | 6.1 | - | 6.1 | 0 |
| Operation and Maintenance during Construction | 74 | 37 | 111 | 0.2 | 0.1 | 0.3 | 33 |
| Administration and Engineering | 1,110 | 888 | 1,998 | 3.0 | 2.4 | 5.4 | 44 |
| Consulting Services and Overseas Training | 111 | 592 | 703 | 0.3 | 1.6 | 1.9 | 84 |
| Sub-total | 11,544 | 12,173 | 23,717 | 31.2 | 32.9 | 64.1 | |
| Contingencies | | | | | | | |
| Technical | 1,332 | 1,702 | 3,034 | 3.6 | 4.6 | 8.2 | |
| Price | 2,146 | 2,627 | 4,773 | 5.8 | 7.1 | 12.9 | |
| Total Project Cost | 15,022 | 16,502 | 31,524 | 40.6 | 44.6 | 85.2 | 52 |

Financing

4.20 Bank/IDA financing would cover the estimated foreign exchange cost of the project (US$44.6 million), which is about 52% of project cost. It would consist of a US$15 million IDA credit and US$29.6 million Bank loan. In addition, the loan component would include US$3.4 million for interest during construction thus bringing the total Bank/IDA financing to US$48 million. The computation of foreign exchange costs assumes all civil works to be carried out by local contractors as has been the experience to date on Loan 600-KO. Except for cement, all equipment, materials and supplies would be imported. To the extent that local suppliers would be the successful bidders on these contracts up to US$2 million of local currency financing might be involved.

4.21 The borrower of the Bank loan would be ADC. It would also receive from Government the proceeds of the IDA credit on the same terms as the Bank loan. Local expenditures, representing the estimated balance of project costs, would be met through Government budgetary allocations to ADC. A breakdown of projected expenditures, including interest during construction, and a quarterly disbursement schedule are presented in Annex 6.

Procurement

4.22 All civil works under the project would be carried out by contractors selected on the basis of international competitive bidding. ADC, with the assistance of the consultants, would be responsible for these contracts. The domestic civil engineering contracting industry has grown rapidly in recent years and has demonstrated considerable capacity and competence to perform major public works in Korea as well as overseas. Most local contractors are well equipped and are expected to be the successful bidders on all contracts under the project. Present planning calls for eight civil works contracts to be awarded during 1972-73. To ensure that contracts would be large enough to attract major local construction firms and international contractors, assurances were obtained that civil works contracts would amount to at least US$4.0 million.

4.23 Contracts for equipment, materials and supplies, with an estimated cost of US$12.4 million (Annex 6), would also be tendered internationally. Responsibility for these contracts would rest with the Office of Supply of the Republic of Korea (OSROK) which is presently performing similar functions satisfactorily under Loan 600-KO. ADC, with the assistance of the consultants, would, however, retain responsibility for preparation and evaluation of the technical aspects. Imported equipment, materials and supplies under the project would be exempted from customs duties. A 15% preference margin, or the prevailing customs duty if lower, would be extended to local manufacturers in the evaluation of bids.

4.24 Under existing regulations in Korea, foreign firms must be registered in the country before they can participate in any local bidding but because of the short period between advertising and opening bids, it is usually impossible for firms not previously registered to comply with this requirement. Assurances were obtained that non-Korean firms would not be required to register in Korea as a condition of bidding and, where such registration is required after award of contract, Government would take any necessary action to facilitate its accomplishment.

Disbursement

4.25 Disbursements would be made against the CIF cost of imported equipment, materials and supplies and foreign exchange payments for consulting services. For equipment, materials and supplies to be awarded to local suppliers, disbursements would be made against the ex-factory price. Disbursements for civil works contracts would be made on a percentage basis representing the estimated foreign cost of the works against certificates of expenditures or work completed certified by the consultants. Savings in any

category under the allocation of proceeds would be made available for overruns in any other category. Undisbursed funds would be cancelled.

Project Accounts and Audit

4.26 ADC would maintain a separate account for the project, following current accounting procedures, which are satisfactory. At present, ADC is not subject to an independent financial audit and assurances were obtained that it would select an independent accounting firm, acceptable to the Bank/IDA to audit project accounts annually and that a certified copy of such auditing would be sent to the Bank/IDA within four months after the close of each fiscal year.

Project in Relation to Ecological Conditions

4.27 With virtually all of the project area under cultivation at present and one third already receiving irrigation, it is not expected that implementation of the project would change the ecological conditions in the area. A controlled balance between man and land exists at present even though the population density is high and the land is used intensively. Land consolidation and on-farm development throughout the project would improve soil and water conservation practices. The reservoirs, which would be relatively small, would be located in the foothills of the surrounding mountains, outside the heavily inhabitated area, and would have no great effect on existing natural conditions. Storage of runoff into these reservoirs would only reduce the normal flow of the rivers by 10 to 15% during the flood season and reservoir releases would help maintain the minimum flow during the dry season.

## V. ORGANIZATION AND MANAGEMENT

Implementation of Project Works

5.01 ADC, a semi-autonomous public entity within the Ministry of Agriculture and Forestry (MAF), would have overall responsibility for the project. Established in early 1970 following consolidation of the Union of Land Improvement Associations and the Groundwater Development Corporation under the Rural Development Promotion Law, ADC has broad responsibilities for the development of land and water resources in rural areas throughout Korea. ADC is headed by a president, a vice president and a board of directors consisting of four members. The president and vice president are appointed for a four-year term by the President of the Republic of Korea, while the directors and other senior staff are appointed by ADC's president. The corporation is divided into seven departments (Administration, Survey and Design, General Projects, Development Projects, Special Projects Administration, Farm Machinery and Technical Cooperation); a special unit has been set up to look after the investigation and design of the Yong San Gang project.

5.02 Responsibility for implementing the Pyongtaek-Kumgang project (Loan 600-KO) rests with the Special Projects Administration Department (SPAD), which was set up specifically for this purpose. The department is under the direct supervision of one of ADC's directors. As originally conceived, most of SPAD's activities on the project were to be carried out at ADC's Seoul headquarters. It soon became apparent, however, that such an arrangement was impractical and consequently most of SPAD's staff were assigned in late 1970 to two field offices in the project area. SPAD's design staff would be reassigned to work on the Yong San Gang project when it completes work on the Pyongtaek-Kumgang project, probably in early 1972.

5.03 Responsibility for day-to-day activities on the Yong San Gang project would be delegated to a project field office to be set up in Kwang Ju. The office would be headed by a senior department head of ADC, acting as project manager, assisted by a deputy project manager, who would also act as the project chief engineer, and four division heads in charge of design, construction, agriculture and administration (Annex 7). Four branch offices would be established at each of the major construction sites to supervise work. The present project staff at Seoul would be moved to Kwang Ju and additional staff transferred from other departments within ADC to meet project requirements. About 250 staff would be required during the peak year of 1975. A senior official of ADC at the director level, would supervise all activities on the Yong San Gang project. He would be assisted by a senior agriculturalist and would ensure overall coordination of both Bank-assisted projects with the rest of ADC's activities. Assurances were obtained that ADC would:

(a) set up a project field office along the lines described above;

(b) appoint the necessary project staff at headquarters and the field office to ensure completion of work by 1977; and

(c) consult with the Bank/IDA before making appointments to the posts of director in charge of the project and project manager.

5.04 At present ADC has a staff of about 1,400, many of whom were with the agency's predecessor. It has also gained some experience on the Pyongtaek-Kumgang project in organizing and planning the construction of a large-scale project. However, while ADC's staff is competent and highly dedicated, it is not geared to administer two major projects simultaneously, to prepare a feasibility study for a third one and to discharge its other responsibilities throughout the country. To ensure rapid and sound implementation of the project, it would therefore be necessary to engage a consulting firm with broad experience in the planning, design and construction of large-scale irrigation projects.

5.05 The consultants would prepare final designs and tender documents, evaluate bids, supervise construction and certify payment to contractors. While they would have final responsibility for these aspects, most of the

design and field work would be carried out by ADC staff. A draft outline of the consultants' terms of reference is presented in Annex 8. The consultants would also prepare a feasibility study for a second stage project in the basin and provide on-the-job training for local staff. They would also assist ADC in planning and executing an overseas training program for professional and administrative staff in the major disciplines related to implementation and future management of the project. The employment of a consulting firm under terms of reference approved by the Bank/IDA would be a condition of loan effectiveness.

Project Coordinating Committee

5.06 Project farmers would receive the necessary supporting agricultural services through the appropriate Government agencies (para 5.14). Most of these services would have to be intensified during the construction period and their success would depend largely on proper coordination of activities between the various participating agencies. Responsibility for such coordination and the preparation of an overall plan for supporting agricultural services would rest with a coordinating committee to be established specifically for the Project. This committee would be chaired by the Provincial Deputy Governor and include senior representatives from MAF, ADC, NACF and ORD. Responsibility for coordinating the actual implementation of the programs in the field would rest with ADC (Annex 9). Assurances were obtained that a plan for supporting agricultural services would be prepared and, after having been reviewed by the Bank/IDA, implemented within one year after signing of the loan/credit agreements.

Project Charges

5.07 Under Government policy, Korean farmers belonging to water users associations, locally known as Land Improvement Association (LIA) and benefitting from irrigation development, are required to pay the cost of operation and maintenance of the project and 40% of the capital costs, with interest at 3.5%, normally over a period of 30 to 40 years. In accordance with this policy, farmers participating in the project would have to pay Government about US$1.8 million per year. This, together with an estimated annual operation and maintenance cost of US$36 per ha, would amount to about US$90 per ha per year. Discounted over the life of the project (50 years) at an opportunity cost of capital in Korea of 12%, the present worth of project capital, operation and maintenance costs, is US$64.0 million while that of revenues from water charges is US$9.2 million. The present worth of the Government subsidy to project beneficiaries is therefore US$54.8 million over the life of the project; the revenues cover about 14% of the costs.

5.08 The proposed project charges would not apply uniformly to all lands in the project. Areas with partial irrigation are already obligated to repay certain capital costs for the works now in place. Further, the present supply to such areas is obtained largely by pumping, which is an additional cost. Since the project would provide only a supplemental water supply to these lands, about 20 to 25% of the requirement, farmers should not be expected to repay the cost of common works at the same rate as farmers on the

newly irrigated lands, which would receive a full supply. The exact repayment rate for these areas would be determined by ADC during the construction period (para 5.09).

5.09 The policy, on the part of Government, to recover only 40% of the investment from farmers, has the effect of not imposing an undue financial burden on small farms and thus weaken the incentive to improve and intensify agricultural practices. Total project charges, including operation and maintenance, would vary from 16% to 21% of the incremental farm income (para 6.10). At the same time, however, the present policy fails to take into account the income disparity between the large and small farmers and in the absence of income taxes on agricultural income, it therefore tends to extenuate the existing disparity. Thus if the Government contribution toward the cost of the project is to be distributed among the beneficiaries in some relationship to per capita income, the percentage of incremental income to be recovered by Government on the larger holdings should be substantially greater than on the smaller ones. The Government has agreed to cause ADC to study the mechanism through which such a scheme could be introduced and also how to compensate members of existing LIAs for payments assessed against irrigation facilities already in operation in the area. In addition, assurances were obtained that water charges would be imposed and collections made in the project areas so as to recover the annual operation and maintenance costs and the equivalent of 40% of the capital cost at 3.5% interest over a period not to exceed 40 years.

Operation and Maintenance

5.10 Responsibility for operation, maintenance and recovery of investment funds on existing irrigation projects in Korea rests with the LIA's. These associations operate as independent units although their annual operating budgets must be approved either by the Provincial Government or the MAF, depending on the size of the project. Most LIA's also engage extension workers to assist their members. Five LIA's, covering the 12,500 ha of partially irrigated land, are presently operating in the project area.

5.11 Government has not yet decided on a plan for operation and maintenance of the project or the role the LIA's would have in this activity. It is generally agreed that responsibility for operation and maintenance of the dams, main canal and main drainage systems, which could be carried out more effectively by a centralized agency, should be delegated to ADC. The existing LIA's, however, have been successful in managing the smaller projects at the farm level, usually not more than 3,000 ha, and it would be worthwhile to consider forming additional LIA's to manage the newly irrigated land in the project. These LIA's would have responsibility to operate and maintain the on-farm systems, schedule water deliveries, allocate and collect project charges, provide extension service and enter into cooperative arrangements with other agencies, such as NACF and ORD, for various kinds of assistance to the farmers. There is considerable evidence that the LIA's work better in areas of a limited size and, for this reason, one or two LIA's covering the entire project would not be advisable. Assurances were obtained that ADC would prepare a plan for operation and maintenance of project facilities along the lines indicated above and present it to the Bank/IDA

for its review and comments within three years after signing of the loan/credit agreements.

5.12 To ensure that actual or potential deficiencies in the structures or the methods of operation would not endanger the safety or affect the satisfactory functioning of the dams, assurances were obtained that ADC would make arrangements to carry out periodic inspections at intervals not exceeding five years and submit a report to the Bank/IDA at such time on the condition of the structures and the measures taken to maintain and operate them in a safe and satisfactory manner.

5.13 Upon completion of the project, the estimated annual operation and maintenance cost would be US$1.2 million, or about US$36 per ha. The estimates are based on 26,500 ha of gravity irrigation and pumping for 6,500 ha. The cost of operation and maintenance in the areas served by pumps, which is based on actual figures, is about double the estimated cost for those lands served by gravity. All costs are based on 1971 unit prices and include operation and maintenance on dams, main canal systems, on-farm systems, main drainage systems and roads. They also include staffing and support costs of ADC's project office as well as for a full complement of water masters and gate tenders to serve each of the subproject areas, but exclude the cost of extension services.

Supporting Agricultural Services

5.14 The Office of Rural Development (ORD) is the main Government agency responsible for agricultural extension, research and demonstration throughout Korea (Annex 10). Under the project, ORD would emphasize work related to irrigation and drainage practices, use of farm machinery, cultivation of vegetable and fruit crops and proper application of lime and agricultural chemicals. ORD is well organized and the quality of its staff is high. To meet project needs, however, its field staff would have to be increased from the present level of about 60 extension workers to 125. In addition, with the exception of work on rice all of ORD's applied research activities are presently concentrated on rainfed crops and there is an immediate need to introduce a research program on irrigated crops. Assurances were obtained that Government would arrange for ORD to:

(a) increase its extension staff in the project area to 125 by 1976; and

(b) initiate, within one year after signing of the loan agreement, a program of applied research on irrigated crops in the project area.

5.15 Fertilizers and pesticides are provided to farmers through the primary and special purpose cooperatives of the National Agricultural Cooperative Federation (NACF). The distribution of these inputs is efficient and there is no shortage of supply. Short-term credit to finance farm activities, which is also supplied through NACF, however, is in short supply and, as a result, most farmers, especially the smaller ones, must rely on

private money lenders at high interest rates. The timely availability of agricultural credit in adequate quantities and at reasonable rates is essential to the success of the project. NACF short-term loans of about W 13,500 per household presently account for half the farmers' agricultural credit requirements. Assuming that demand for credit under the project would remain at the present ratio to total production costs (54%), NACF would have to increase its loans in the area from the present W 600 million to W 1.5 billion at full development (both figures expressed in 1971 prices). Assurances were obtained that adequate amounts of short-term credit would be available to farmers in the project area at all times.

5.16 Government has recently introduced a farm mechanization program throughout the country under which NACF would make credit available to farmers for the purchase of power tillers and other equipment. Further, Government has obtained a loan from USAID of US$8.0 million for this credit program, including an additional US$6.0 million for grain storage facilities. In addition, an agricultural credit project has been appraised by the Bank that would also provide credit for machinery for orchard and sericulture development. In view of the labor shortage in the area (para 6.03) the project would require about 4,000 power tillers at full development. Assurances were obtained that NACF would give high priority to the mechanization program in the project area.

5.17 Slightly less than half the rice produced in the country and about one-quarter of the barley enter commercial marketing channels, with most sales being handled by private traders. Foodgrains are also purchased by the MAF as part of the price stabilization program through the Grain Management Special Account (GMSA). GMSA's rice and barley purchases in 1969 accounted for 18% and 40%, respectively, of all quantities entering commercial channels. Various marketing functions are also provided by NACF's primary and special purpose cooperatives (Annex 11). Existing marketing arrangements are satisfactory and no difficulties are anticipated in meeting the project needs.

5.18 The principal storage place for rice is the farmer's home, while commercial storage capacity in the province is about 180,000 tons at 825 different sites. About 40% of the capacity is owned and operated by the private sector, 55% by NACF and the balance by MAF. As part of its program to consolidate member cooperatives, NACF plans to expand its warehouse capacity but this would meet only part of the project needs and would have to be augmented by the construction of new storage facilities by the private sector. To date, private traders have been responsive to market needs, and an expansion of their capacity may be expected with the increased production on the project.

## VI. PRODUCTION, MARKET PROSPECTS, PRICES AND FARMERS' INCOME

### Production

6.01 Rice is presently the predominant crop in the project area, accounting for about half the cropped area and nearly 80% of the value of production. Due to erratic rainfall, however, there are considerable variations from year to year in the area actually planted and harvested. Some improvement of rice as well as other crop yields could be expected even without the project although, in the absence of an assured regulated water supply, such increases are not likely to be very significant 1/. Expected yield levels in ton/ha for the main irrigated crops under the project are as follows: 2/ rice, 4.2 (2.8); barley, 3.0 (2.2); white potato, 16.0 (10.0); sweet potato, 23.0 (15.0); chinese cabbage, 28.0 (12.0); garlic, 9.0; and onion, 30.0. These yield levels would be reached gradually over a five-year period following the start of irrigation. Details of yields, production, prices and costs are given in Annexes 12 and 13.

6.02 Following completion of the project, the overall predominance of rice and barley in the cropping pattern is expected to decline due to a reduction in the barley area and an increase in the area devoted to upland crops. At the same time, the overall cropping intensity on the project would increase from the present 163% to 182%, as summarized below:

| | Cropped Area | | Production | | |
|---|---|---|---|---|---|
| | Present | Future | Present | Future | Increment |
| | (ha) | | ('000 ton) | | |
| Rice | 24,200 | 24,000 | 63 | 100 | 37 |
| Barley | 20,000 | 13,000 | 44 | 39 | (-5) |
| Potatoes | 2,300 | 10,000 | 30 | 188 | 158 |
| Miscellaneous Vegetables | 2,200 | 6,800 | 23 | 117 | 94 |
| Others | 1,800 | 6,200 | - | - | - |
| Total | 50,500 | 60,000 | | | |

6.03 Labor requirements under the project would be concentrated into two peak periods of about three weeks each coinciding with the barley harvesting-rice transplanting during May-June and rice harvesting-barley planting during October-November. Together these two periods would account

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1/ These increases, which were assumed at 2% per year for the purpose of economic analysis (para 7.04), have not been incorporated in this Chapter of the report.

2/ Figures in parenthesis represent current yields.

for nearly half the annual labor requirements on the project. With the expected increase in cropping intensity and yields under the project, labor inputs would increase by about 35% over the present level. Such an increase could not be met from the existing labor pool in the area, and it is therefore expected that farm activities would have to be mechanized to the extent necessary to offset the labor shortage. Should the need arise, further mechanization of farm activities such as transplanting, harvesting and drying would be possible.

Market Prospects

6.04 According to the draft Third Five-Year Plan (1972-1976), the overall foodgrain deficit would remain at about 2.1 million ton per year. The rice deficit, which is estimated at 1.0 million ton in 1971, however, would be eliminated by 1976. With limited land resources and a continuous shift from food crop to more remunerative commercial and horticulture crop production, virtually all of the increased rice production would have to come through higher yields. Based on various rice demand forecasts an annual increase in productivity of around 2.6% would be necessary to attain self-sufficiency by 1976. Most available data indicate, however, that this is unlikely since the increased annual productivity during the last five years has been under 2.0%. The same would hold true for other foodgrains. Under the circumstances, rice and barley to be produced on the project should be easily sold in the domestic market.

6.05 Except for foodgrains, there are no reliable demand forecasts for the various crops to be produced on the project. In the absence of such data, the country wide demand for selected crops was assumed, on the basis on projected population and income growth, to increase 3.5% per year over the 1965-69 average consumption level. Except for onions, where there is good export potential to Japan, project production was limited to under 10% of the 1980 demand figures. Considering the conservative basis of such a forecast, the favorable climate conditions of the area compared with the rest of the country, and proximity to major urban areas, project produce should find a ready market. Furthermore, given the wide range of crops already being produced in the area, farmers would have no difficulty in shifting production from one crop to another should market constraints arise.

Prices

6.06 The eventual cropping pattern on the project would depend largely on the price relationship between the various crops. For foodgrains, this relationship is subject to direct Government intervention in the market. Faced with a growing foodgrain deficit, Government intends to curtail rice consumption by maintaining rice prices at a relatively high level in relation to wheat and barley. To this end, it is presently following a dual-price policy, under which it purchases rice through the price stabilization program at above market prices during harvest time. In addition to imported rice, these purchases, which presently amount to about 10% of local production

(para 5.17), are then released during peak demand months for sale to urban consumers at prices about 10% below the purchase price. The differences between the buying and selling prices, plus storage and handling charges, are absorbed by Government. The net impact of this program is expected to encourage rice production, increase farm income and at the same time stabilize rice prices to the consumer. On the other hand, a low barley price relative to rice would impede the Government's plan to increase barley production. In preparing the farm budgets, it was assumed that rice and barley prices would remain at about their mid-1971 level.

6.07 The high rice price policy might bring about misallocation of resources by encouraging rice production on land better suited for other crops. Furthermore, since small farmers who produce mainly for their own consumption do not benefit from this policy and low income urban workers are faced with higher prices, the policy is unlikely to bring about an equitable redistribution of income. The rice price policy, including its possible adverse effects, was discussed during negotiations. It is presently being reviewed by a team of experts from Michigan University sponsored by USAID and would also be examined by a Bank agricultural sector mission in the second half of 1972.

6.08 Next to foodgrains, the main commodities to be produced on the project are potatoes, miscellaneous vegetables and fruit. All these commodities are subject to wide seasonal and annual price fluctuations. In the absence of data on market arrivals, however, it was impossible to establish a correlation between quantities marketed and prices. The price adopted in this report is based on the average 1965-70 annual price, adjusted to the 1971 level.

Farmers' Income

6.09 In calculating the farm income it was assumed that the number of man-days contributed by both family labor and hired labor at full development would remain at the present level. Because of labor shortage in the area, increased output under the project would require at least partial mechanization of farm activities. Farm production costs (Annex 12) reflect the increased use of machinery. Present and projected farm production costs exclude family labor contribution. All hired labor requirements were priced at W 540 per day, which represents the average wage for male and female workers. Farm activities, and likewise production costs, assume the use of power sprayers, semi-automatic threshers and power tillers for land preparation and transportation wherever practicable. The cost of machinery was adjusted to reflect the recent devaluation of the won and is based on the going market rate for hired equipment, including operators' wages.

6.10 Although half the rice fields in the project area are currently under partial irrigation, present returns do not differentiate between rainfed and irrigated farms, and all returns from rice represent the weighted average of both types of cultivation. Based on the findings of a recent farm household survey, the cropping pattern on the different farm sizes was assumed

to be the same although family labor contribution varies considerably, ranging from 84% of total labor requirements on the 0.3-ha farm model to 53% on the 3.0-ha farms. Four representative farm models were examined. In each case, in addition to the income derived from farming, the family income is supplemented through work in other sectors. Non-farming income is especially important on the 0.3- and 0.7-ha farm models, where it accounts, respectively, for nearly 50% and 23% of total income under present conditions. On the larger farms, it becomes considerably less important, accounting for under 15% of total income. With the number of family labor man-days available for work off the farm remaining the same (6.08), earnings from non-farming activities was assumed to increase in line with the general growth of income through the economy.

6.11 The projected increase in farm income, after deducting all project charges, would nearly double on all four model farms, the largest increase occurring on the 3.0-ha farms that account for about 10% of the project area (para 3.09). For all farm sizes, however, the expected increase in family income would be substantial and should guarantee the farmers' participation in the project. Detailed analyses of annual farm income at present and at full development are presented in Annex 13 and summarized below:

Farm Income

| Farm Size (ha) | Present | | | Full Development | | | Increment | | |
|---|---|---|---|---|---|---|---|---|---|
| | Farming | Non-farming | Total | Farming | Non-farming | Total | Farming | Non-farming | Total |
| | ('000 Won) | | | | | | | | |
| 0.3 | 67 | 68 | 135 | 132 | 134 | 266 | 65 | 66 | 131 |
| 0.7 | 151 | 46 | 197 | 305 | 90 | 395 | 154 | 44 | 198 |
| 1.5 | 294 | 46 | 340 | 578 | 90 | 668 | 284 | 44 | 328 |
| 3.0 | 526 | 60 | 586 | 1,272 | 118 | 1,390 | 746 | 58 | 804 |

## VII. BENEFITS AND JUSTIFICATION

### Economic Analysis

7.01 The project would bring about a substantial increase in agricultural production, almost entirely through higher productivity; a diversification of farm activities from the rice-barley sequence into higher value crops; an increase in farm income; and, through the increased production of rice and cereals, a reduction in Korea's foodgrain deficit. It would also contribute significantly toward realizing Government's goal of bringing about a more equitable income distribution between the urban and rural areas and becoming self-sufficient in rice production.

7.02 At US$2,500 per ha, costs are high by comparison with most other Bank-financed irrigation projects. While these costs are due, in part, to the irrigation canals having to traverse long distances through undulating terrain before reaching the project areas, much is the result of installing a highly intensive and sophisticated system, which, following land consolidation, would provide fields, averaging about 0.3 ha, with their own irrigation inlet and drainage outlet as well as access to a farm road. Under such a system, it is possible to control irrigation and drainage at all times and thereby to obtain exceptionally high yields and income per unit of land. Considering the extremely limited opportunities to further expand the cultivated land in the country, the small size of virtually all farms and the tremendous industry and ability displayed by the Korean farmer, such high investments are justified both on economic and social grounds.

7.03 In evaluating project benefits, rice and barley prices were based on the Bank Economics Department's world market price projections for 1980 while all other crops were based on the 1965-70 average farm gate price expressed in 1971 prices (see para 6.06). All hired labor requirements have been costed at the going market rate. Irrigation was assumed to be introduced over a three-year period, commencing at the end of the construction period, and incremental benefits to accrue gradually over a five-year period following the start of irrigation.

7.04 At full agricultural development in 1982, the net value of agricultural production would be US$20.3 million, with most of the increase being accounted for by garlic, potatoes, rice, Chinese cabbage and orchards. The corresponding value without the project would have been about US$3.8 million. When discounting the incremental benefits and relevant costs over the 50-year life of the project, the economic rate of return would be about 13%. The analysis also shows that there are no significant differences in the economic benefits between the four subprojects. The net present worth of foreign exchange earnings, at a discount rate of 12%, is US$44.8 million while the internal foreign exchange rate is W 303 to the US$, which is appreciably better than the official exchange rate of W 370 (Annex 14).

7.05 A sensitivity analysis was carried out to examine the following adverse conditions: 30% reduction in the rice cropped area; 50% reduction in the onion and garlic cropped area; 20% increase in farm production costs; 30% increase in construction costs; three year extension of the construction period; and five year extension of the development period. In each of these cases the rate of return would exceed 10%. Assuming any two of the above events should occur simultaneously, the rate of return would still be around 9%. Further details are presented in Annex 14.

Income Distribution

7.06 The rapid industrial growth during the past decade has brought about a serious income gap between the urban and rural areas. To combat this growing disparity, Government has taken two major steps -- it accelerated the development rate of irrigation projects, which permits both increased

productivity and diversification of farm activities, and it raised the rice procurement price. The Yong San Gang project, which would benefit some 45,000 farm families, is expected to make a significant contribution towards meeting Government's goal of raising rural incomes. Under the project, the average estimated per capita income would increase from its present level of US$85 to US$180 at full agricultural development. This increase in earnings would prevent a further widening of the income gap between the beneficiaries and the rest of the economy, although even at full development, per capita income in the area would still be below the present national average of US$235 or the projected figure for 1982 of over US$400.

## VIII. AGREEMENTS REACHED AND RECOMMENDATIONS

8.01 During negotiations, agreement was reached on the following principal points:

(a) the water rights of all lands under the project would be legally recorded and the normal and regulated flow of the rivers protected from future depletions that could adversely affect the supply to the project (para 4.14);

(b) non-Korean firms would not be required to register in Korea as a condition of bidding and, where such registration is required after award of contract, Government would take any necessary action to facilitate its accomplishment (para 4.24);

(c) ADC would undertake the following:

(i) set up a project field office in Kwang Ju to be in charge of all project works;

(ii) appoint the necessary project staff at headquarters and the field office to ensure completion of work by 1977; and

(iii) consult with the Bank/IDA before making appointments to the posts of director in charge of the project and project manager (para 5.03);

(d) a plan for supporting agricultural services would be prepared and, after having been reviewed by the Bank/IDA implemented within one year after signing of the loan/credit agreements (para 5.06);

(e) water charges would be imposed and collections made in the project area to cover operation and maintenance costs and to recover the equivalent of 40% of the capital cost at 3.5% interest over a period not to exceed 40 years (para 5.09);

(f) ADC would prepare a plan for operation and maintenance of project facilities, including periodic inspection of the dams, and present it to the Bank/IDA for review and comments within three years after signing of the loan/credit agreements (paras 5.11 and 5.12);

(g) the Office of Rural Development would increase its extension staff in the project area to 125 by 1976 and commence, within one year after signing of the loan agreement, a program of applied research on irrigated crops in the project area (para 5.14); and

(h) adequate short-term credit would be available to the farmers in the project area and high priority would be given to the mechanization program.

8.02 In addition to the customary conditions, the following has been agreed upon as a condition of effectiveness of the proposed loan/credit:

(a) the employment of a consulting firm acceptable to the Bank/IDA under terms of reference approved by the Bank/IDA (para 5.05).

8.03 With the indicated assurances, the proposed project constitutes a suitable basis for a Bank loan of US$33 million, for a term of 30 years including a six-year grace period and an IDA credit of US$15 million.

December 21, 1971

# KOREA

## YONG SAN GANG IRRIGATION PROJECT - STAGE I

## Soils

### Soil Survey and Land Classification

1. In 1967 a detailed reconnaissance soil survey of Korea was conducted by the Office of Rural Development (ORD) of the Ministry of Agriculture and Forestry (MAF) and UNDP/FAO. A 1:1,000,000 map and an accompanying outline in English, briefly describing the main soil groups of Korea, are available but the full report has not yet been published.

2. In 1967-1970 ADC conducted a semi-detailed soil survey and land classification of the project area. Base maps used were derived from 1:10,000 aerial photo. Auger borings were made according to a grid system at 100 m intervals and larger holes, one for each 100 ha, were dug to reach the parent material. Considerable data on land and soil properties were assembled in the field and tested in the laboratory in order to conduct a land classification based on the USBR system. The information obtained, however, was incompetently assembled and the land classification was not properly done, as existing irrigation and drainage facilities were studied instead of the potential irrigation and drainage suitability based on soil characteristics.

3. Notwithstanding the inadequate report, examination of the assembled data and observations made in the field give sufficient evidence that the project area is suitable for development of irrigated double cropping after land consolidation and benching. A breakdown of project lands by subprojects and districts is given in Table 1.

### Suitability for Irrigated Double Cropping on Paddy Land

4. The low land paddy soils consist of loam and silt loam down to over 1 m deep, with clay content increasing moderately with depth. The drainage is imperfect, largely due to the high silt content which varies from 30% to 50%. Percolation rates vary from 3 to 5 mm per day. After consolidation, paddy lands would be provided with farm drains at 100 m intervals, which would be adequate to remove surplus surface runoff.

5. Barley, the main winter crop, is planted in early November (10 to 20 days after the rice harvest); it produces a good stand by utilizing residual moisture after rice but irrigation would be provided in November when the autumn has been unusually dry. No irrigation would be applied from December to February, when the ground freezes. Supplementary irrigation would be supplied in March, April and May, the largest requirement occurring in May corresponding with the maturation period of barley. There is no subproject area with a calculated monthly irrigation requirement exceeding 10 cm and

upland crops would be planted on beds varying from 0.3 to 1.2 m wide with 10 cm deep furrows in between. Land consolidation enables low volume irrigation to be supplied to each plot of an average size of 0.3 ha.

6. No groundwater data are available for the project area. Farmers interviewed, however, complain about dry spells, rather than inadequate drainage in spring months. There has been no difficulty in draining water from plots after fairly heavy spring rains on land already consolidated.

7. The fact that the project area already has a 160% cropping intensity indicates a satisfactory general drainage pattern. Low spots are being used for establishing rice nurseries in April and May where winter crops would not be grown. The proposed supplementary winter and spring irrigation with improved drainage by land consolidation would not create a drainage problem on the paddy land.

Suitability for Irrigated Double Cropping on Upland

8. Upland soils vary mostly from 70-100 cm in depth, and from silty clay loam to clay loam in texture, the clay content increasing with depth. Drainage has not been a problem on upland where slopes are generally over 9%. Even in areas where drainage of low land has been a problem for winter cropping, upland has always been fully double cropped or planted to orchard trees. The project work would include benching and terracing of upland soils which are easily erodible. Irrigation and drainage ditches would be constructed for supplying water to and draining water from the benched/terraced plots. In May the maximum calculated monthly irrigation requirement in all subprojects does not exceed 14 cm. Those for other months are considerably smaller. With the planned irrigation schedule, the benching and terracing, and the building of drainage channels, drainage would not be a problem in the future.

Salinity and Acidity

9. No salinity has been detected in any of the samples analyzed. Electric conductivity determinations have been made on most of the samples taken. None has a value exceeding 0.2 mmho/cm.

10. Soils in the project area are generally acidic, which is common to soils derived mainly from granite parent rock and by podzolization process, during which most of the base elements are leached out. Soil pH data surveyed by the UNDP Soil Fertility project and by the ORD Guidance Bureau vary considerably, but they agree in one respect, e.g. at least 85% of all the samples taken have pH value below 6, and at least 75% have pH value below 5.5.

Liming Program

11. To prepare a full liming program for the project, ADC conducted in 1969 and 1970 a detailed field pH test in all subproject areas. Using an ORD kit which is now a standard equipment for quick field pH tests in Korea, one sample was taken for each 10 ha. The result confirmed earlier surveys.

The pH values were recorded on 1:3,000 maps that show boundaries of individual farm parcels. The same base maps are being used by ADC for designing the canal layout and land consolidation.

12. ORD has conducted liming experiments on rice, barley and soybean and established adaptable pH ranges for various crops. It recommends that, for achieving maximum crop yields, the pH of double cropped paddy land (rice followed by winter upland crop) should be adjusted to 6.5, and that of the single rice crop paddy field, to 6.0. It also recommends that a sufficient quantity of lime be applied as an initial dosage to bring the soil pH at once to the desired level, and maintenance application be made on every fourth year. Using the ORD kit, extension officers can directly determine the lime requirement from readings in the field.

13. Korean farmers are familiar with lime application and MAF has been sponsoring a national subsidized liming program for a number of years. The program received a 70% subsidy in 1970 and currently receives a 100% subsidy. From 1966 to 1971, the amount of lime supplied to farmers annually under the program in Jeonla Nam Do province varied from 45,000 to 67,000 tons. According to the Provincial ORD, the province would need about 500,000 tons to make a proper initial application on 30% of the paddy fields and 60% of the upland. If a four-year rotation is made on all the land needing treatment, some 125,000 tons would be required annually. The present supply level meets about one-half to one-third of the annual need, the limiting factor being the Government budget available for subsidy. Because of the insufficient quantity, lime is divided among provinces, counties and villages. Some farmers do not use lime at all, others use 1 or 2 tons per ha. Some lime (slake lime) probably finds its way into non-agricultural uses. In short, the existing program would not be adequate for adoption in the project area where full yield development is expected five years after completion of the project works.

14. Under the project, the liming program would be executed in the following manner:

(a) ADC's field office and Jeonla Nam Do Provincial ORD would jointly estimate the lime requirement of each consolidated or benched land block;

(b) the Jeonla Nam Do Provincial Government would order shell powder of proper mesh from private lime factories and contract the Korean Transportation Corporation to transport and deliver the lime to each land block. The cost of lime would be borne by the Government subsidy program. These are standing practices of the provincial lime program; and

(c) contractors for land consolidation or benching would apply the desired amount on each plot of land. Farmers would spread the lime and plow into soil upon completion of land consolidation and on-farm development.

15. The estimated lime requirement for the initial application in the project is given in Table 2.

October 13, 1971

ANNEX 1
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Distribution of Land by Subprojects

| Sub-Project | Source of Water Supply | Irrigation Division | Area Under Cultivation (ha) Rainfed | Partial Irrigation | Total |
|---|---|---|---|---|---|
| Dam Yang | Yong San Gang River | Dam Yang | 1,620 | 1,820 | 3,440 |
| | | Kwang San | 3,610 | 1,300 | 4,910 |
| | | Sub-Total | 5,230 | 3,120 | 8,350 |
| Jang Seong | Hwang Yong River | Jang Ham | 4,650 | 4,400 | 9,050 |
| | | No An | 2,200 | 680 | 2,880 |
| | | Sub-Total | 6,850 | 5,080 | 11,930 |
| Kwang Ju | Kwang Ju river | Kwang Ju | 1,420 | 800 | 2,220 |
| Dae Cho | Ji Seok Cheon River | Na Ju | 7,000 | 3,500 | 10,500 |
| | | Total | 20,500 | 12,500 | 33,000 |

October 13, 1971

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Initial Requirement of Lime Application

| | Paddy | | | Upland | | | Other 1/ | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | Requirement (tons/ha) | Total Requirement (tons) | Area (ha) | Requirement (tons/ha) | Total Requirement (tons) | Area (ha) | Total Requirement (tons) | Area (ha) | Requirement (tons) |
| Jang Seong | | | | | | | | | | |
| Jang Ham | 6,970 | 1.96 | 13,661 | 1,295 | 4.03 | 5,219 | 785 | 4,297 | 9,050 | 23,177 |
| No An | 1,720 | 2.72 | 4,678 | 720 | 4.63 | 3,334 | 440 | 2,361 | 2,880 | 10,373 |
| Dam Yang | | | | | | | | | | |
| Kwang San | 3,720 | 2.72 | 10,118 | 1,359 | 4.30 | 5,844 | 176 | 1,514 | 5,255 | 17,476 |
| Dam Yang | 2,685 | 2.21 | 5,934 | 364 | 3.75 | 1,365 | 46 | 422 | 3,095 | 7,721 |
| Kwang Ju | 1,795 | 2.21 | 3,967 | 308 | 3.75 | 1,155 | 117 | 371 | 2,220 | 5,493 |
| Dae Cho | | | | | | | | | | |
| Na Ju | 5,525 | 3.31 | 18,288 | 2,183 | 5.51 | 12,028 | 997 | 6,882 | 8,705 | 37,198 |
| Dae Cho | 1,795 | 3.31 | 5,941 | - | - | - | | | 1,795 | 5,941 |
| Total | 24,210 | | 62,587 | 6,229 | | 28,945 | 2,561 | 15,847 | 33,000 | 107,379 |
| Average Requirement (tons/ha) | | 2.59 | | | 4.65 | | | 6.19 | | 3.35 |

1/ Includes 2,239 ha of forest, 176 ha of orchard, 111 ha of mulberries, 72 ha of bamboo and 85 ha of pasture.

ANNEX 1
Table 2

# KOREA

## YONG SAN GANG IRRIGATION PROJECT - STAGE I

### Description of the Project

### A. Selection and Formulation of the Project

1. In 1964 the Government of Korea initiated the All Weather Farming Program with the objective of providing irrigation, land consolidation and on-farm development to about 500,000 ha of presently cultivated land throughout the country. The overall purpose was to establish an assured source of agriculture and food production which would not be entirely subject to the vagaries of rainfall and recurrent drought. The program was also designed to overcome a part of the persistent food deficit, particularly in food grains, as the increasing need to import food has imposed a heavy burden on the financial resources of the country. With only 30% of the land area in the country suitable for agriculture, it is recognized that increased production will have to come from more efficient use of presently cultivated land as large extensions of new land are obtainable only by costly reclamation of tidal areas.

2. The two most effective means for increasing production are an assured water supply and on-farm development. The recurrent annual droughts during the peak growing season are a continuing constraint on yields and overall production and the long droughts as experienced in 1967-68 have had a severe effect on the total food supply. It is further recognized that irrigation and on-farm development are concomitant as the justification for irrigation development largely depend on maximum and diversified production from the land, which in turn, may only be achieved by efficient water use and farming practices made possible by on-farm development. Furthermore, diversification to food crops other than rice and barley, which is needed to improve the food supply in the country cannot achieve its full potential without irrigation.

3. The possibilities for irrigation development on a large scale in Korea are confined to four large river basins, i.e., the Han, Naktong, Keum and Yong San. Of these the Yong San is considered to have the most favorable conditions with a moderate climate, large contiguous areas of irrigable land, adequate but undeveloped water resources and competent farmers who currently obtain relatively good yields under rainfed conditions and with partial irrigation on a portion of the land. The Government is engaged, with the assistance of USAID, UNDP, IBRD and other sources, in surveys, planning and development in these basins. A long series of droughts, more severe in the Southwest Provinces, with the crisis conditions resulting from the 1967-68 drought, led the Government to a decision to give highest priority

to irrigation development in this part of the country and to proceed rapidly with implementation of projects which could stabilize the situation in an area which contributes a major share of the food supply. The first project was the Pyongtaek-Kumgang in the Keum Basin which is underway with Bank assistance (Loan 600-KO) and the Government now intends to continue the program by implementing Stage I of the proposed Yong San Gang Basin Development, which has been determined as the next most feasible step in the program.

4. Formulation of the Yong San Gang Basin Development Plan (Master Plan) was initiated by ULIA in 1966 and subsequently completed by ADC and Sanyu Consultants in December 1970. This plan envisages utilization of a major part of the available water resources in Jeonla Nam Do province to provide irrigation for about 100,000 ha and to provide for urban and industrial water requirements. The land to be developed includes about 70,000 ha of lower valley land and upland in the Yong San Gang drainage basin and about 30,000 ha to be reclaimed from tidal lands along the west and south coast of the province. Seadikes would be constructed for storage and water supply to the tidal lands whereas dams and reservoirs in the upper reaches of the Yong San Gang and its tributaries could provide an irrigation supply to the valley lands and uplands.

5. The planning methodology included preparation of plans for individual hydrographic units of the basin by optimizing a wide range of development possibilities and comparing alternative proposals. This took into account the unit costs of water resource development and delivery to the land, the cost of land preparation, the net incremental benefits to be obtained and other factors normally used in determining the relative feasibility of individual plans. By means of a systems analysis with a computer these plans were then optimized into a master plan which takes into account the interrelation and the possible inter-linking of individual plans. Since the overall regional plan was obviously too large and expensive to undertake at one time, phasing of development would be required and a Stage I project was selected. Additional studies proved that development of the upper valley lands and adjacent uplands, with reservoirs in the upper watershed, was more advantageous at this time than the more costly and time consuming construction of seadikes and reclamation of tidal lands. The Stage I project was then studied in greater detail to establish and refine the plan for the project, as presented in the feasibility report.

6. The original plan for Stage I included five sub-projects covering 30,000 ha. One of these, Deok Ho, is located along the coast in the northwest part of the province and outside the Yong San Gang basin. The appraisal revealed that this sub-project required further investigation and Government agreed to delete it from present consideration. The four remaining sub-projects covered about 26,000 ha which did not include 7,000 ha contiguous to the project areas, now partially irrigated by direct diversion or pumping from the rivers. These lands, most of which still require consolidation and on-farm development, would require a supplemental supply from project reservoirs for the rice crop and a full supply for winter and spring crops. It was therefore agreed to include these lands in the project, thus bringing the total area to about 33,000 ha.

## B. Description

### General Plan

1. The proposed plan for irrigation development is basically the same for each of the individual subprojects. It would consist of a dam and storage reservoir, a main canal and secondary lateral system, a main drainage system, land consolidation and on-farm development, and roads. The on-farm development includes a tertiary system for irrigation and drainage, land levelling and borders on tracts varying from 0.3 to 0.5 ha, and a farm road system. All land in each of the project areas is presently farmed either as rainfed or partially irrigated from small reservoirs, by pumping or direct diversion from the rivers. The plan for each project takes into account the different water requirements for paddy land and upland and also the integration of existing systems into the main project especially from the standpoint of supplying supplemental water and completing the land consolidation program. This variation in the present status of land in each project area was taken into account in planning the project and in computing costs, water requirements and benefits.

### Dams

2. Construction of the four dams on the project would not present any technical difficulties. Test borings on site indicate that the granite base foundations are sound without major fractures or displacement and with very low permeability. Overburden is relatively shallow, usually not more than 10 m, with a thin layer of decomposed rock over the undisturbed base rock. Construction materials for both the rockfill and zoned earth dams are available within a reasonable distance. Design is conventional for spillways, outlet works and the dams and final design should not involve any major changes which would increase the cost.

3. In all cases a flood regulating surcharge of 2 to 2.5 m has been provided and flood routing studies indicate this is more than sufficient to contain any flood anticipated in the future.

4. An important task related to constructing the dams is that of acquiring and clearing the reservoir right of way. The following table lists the number of people, the amount of land and other facilities that would be involved in this operation. Funds would be provided in the project budget from local currency to compensate farmers for land and existing on-farm development. There are possibilities for relocating some of the farmers on new land or for them to purchase other land. The existing tendency of emigration to the larger cities where employment is available would absorb some of the dislocated people. Such migration may, however, add to the congestion problems in some of the larger cities.

Acquisition of Right of Way in Reservoir Areas

| Type of Development | Unit | Dam Yang | Jang Seong | Kwang Ju | Dae Cho |
|---|---|---|---|---|---|
| Population | ea | 1,810 | 6,138 | 558 | 4,706 |
| Farms - Paddy | ha | 156 | 271 | 72 | 245 |
| Upland | ha | 77 | 100 | 48 | 173 |
| Other land | ha | 233 | 279 | 44 | 416 |
| Dwellings | ea | 292 | 990 | 90 | 759 |
| Public buildings | ea | 3 | 2 | - | 3 |
| Road Relocation | km | 11 | 20 | 5 | 8 |
| Power line poles | ea | 137 | 203 | 60 | 372 |

Main Canal and Lateral Systems

5. The main canals would originate at the storage dams and these together with the secondary laterals would supply the total area to be irrigated by gravity, feeding into the tertiary systems constructed as part of the on-farm development or the existing systems. There are no plans for constructing additional diversions or pumping stations on the project.

6. Design of the system is based on a water duty of 1.4 liters/sec/ha. This fairly high value, which has been set as a standard in Korea, is based on the maximum demand of paddy rice during the month of August. During this critical growth period the system must be adequate to deliver 5 to 10 mm of water to each paddy every day and consequently a reduced system capacity which could be achieved with a rotational delivery schedule is not possible. An overall project efficiency of 60% was assumed in computing water requirements.

7. Construction of the main canal system would be fairly difficult and costly due to the undulating topography on a large part of the project area and the requirement for a relatively long and extensive canal system to serve all the project lands. Also the main canals would be located along the lower part of the foothills and a large number of flumes, siphons, tunnels and other structures would be required to traverse the intensive cross-drainage system. It is not planned to line the main canals, except in critical areas where seepage could be excessive. Tunnels would be lined. Some excavation in rock would be required on that part of the canals immediately below the dam and in tunnels but generally the systems would be constructed in soils which are suitable for unlined canals. The design of all structures in the system follows conventional standards.

8. Design layout, quantities and cost estimates for the main canal system are based on field surveys. The general layout has been plotted on the 1:3000 scale base maps which were used to plan the projects. These maps were prepared from aerial photos and show the existing land tenure together with 1 m contours. They are adequate for surveys and planning on all aspects of project development.

Land Consolidation and On-Farm Development

9. In Korea the term "land consolidation" includes on-farm development such as irrigation and drainage canals, leveling and bordering, structures and roads, as well as the adjustment of farm boundaries into a uniform rectangular pattern. For the purpose of this report the term has been expanded to more accurately describe this work item.

10. In the complete consolidation process, blocks or areas of land are sub-divided into individual tracts 30, 40 or 50 m wide and usually 100 m long. These tracts are arranged in parallel tiers to form an overall rectangular pattern. Each tract which is bordered and leveled for flood irrigation, is provided with an irrigation supply canal at one end and a drainage canal at the other. The irrigation and drainage canals are alternated such that each serves two tiers and a farm road may be constructed along one bank of either canal, as suitable. Due to the shortage of land in Korea the canals, borders and roads should be kept to a minimum size. All dwellings and service centers are located apart from the irrigated area, usually on land not suitable for cultivation.

11. The system described above has been adopted and implemented throughout the country during the past several years as a means to obtain the highest efficiency and production from the limited land resources. This applies primarily to irrigated paddy land where consolidation is considered essential to justify investment in irrigation works and associated facilities. The process may, however, be applied to non-irrigated land and to upland areas. The degree of treatment and cost varies with the condition of the land and the planned use of crops to be grown. The slope of the land and the amount of leveling involved is an important factor. Normally the full treatment is only carried out on rice land which has an assured water supply. In the case of upland which has already been terraced, boundary adjustment may not be practical and treatment may consist only of irrigation and drainage canals and roads. Reclamation of forest or unused land and terracing may be included in the process.

12. During the past several years the consolidation process has been completed on about 135,000 ha throughout the country. The work is usually performed by contract with Government subsidizing 70% of the cost. Government normally pays the total initial cost and recovery of the farmer's share is spread over several years, depending on the specific circumstances. The plan for the Yong San Gang project calls for a total of about 30,000 ha to receive consolidation and on-farm development. This is divided into class of treatment as follows:

| | Area (ha) | Unit Cost ($/ha) |
|---|---|---|
| a) Complete adjustment of boundaries and on-farm development. | 18,500 | 900 |
| b) Boundary adjustment, irrigation, drainage and roads (no leveling). | 4,300 | 625 |
| c) Terracing, reclamation, irrigation, drainage, roads and other facilities. (These lands after treatment will consist of upland terrace with a minor amount of paddy, orchard and pasture.) | 7,000 | 800 |
| d) Land already consolidated or scheduled for consolidation in 1972. | 3,200 | |
| Total | 33,000 | |

Main and Tertiary Drainage Systems

13. The purpose of the main drainage system is to receive surplus run-off from the tertiary on-farm systems and convey it out of the area and into the main rivers and tributaries. This system would be constructed to conform to the topography and the existing natural drainage pattern as far as possible. In many cases improvement of existing or natural drains would be sufficient.

14. The provision of drainage, either main or on-farm, on the project is designed primarily to remove surplus surface water. Under the Korean system for paddy cultivation, a depth of 100 mm is considered optimum for ponding and borders are constructed accordingly. There is a need, therefore, to remove the surplus deposited by heavy rainfall, especially following several days of more or less continuous rain. In addition, the drainage system is required to drain the paddy lands quickly as part of the cultivation cycle but especially at the end of the growing season for harvest and to dry up the paddy for land preparation and planting the winter crop. In the case of barley planting must take place by mid-November, following the rice harvest in late October, if it is to stem properly before the first frost. This allows only a few days between crops which requires that the paddy be drained as rapidly as possible. It was noted, in fact, that a sizeable proportion of existing paddy land could not be second cropped due to a lack of adequate drainage which left the land waterlogged for several weeks.

15. Design of the main and tertiary systems is based on a maximum daily rainfall of 170 mm. Records for the past 30 years at Kwang Ju indicate that this maximum can occur once in 10 years. It is also assumed that several days of continuous rainfall, especially in the paddy areas, can produce 100% run-off. This results in a rather high design duty of 20 liters/sec/ha or 8 liters/sec/ha for each field. Previous experience in the country with projects having a capacity of 15 liters/sec/ha indicates that the higher figure is required to provide adequate drainage.

16. The project investigations included only a cursory examination of groundwater conditions in the area and reliable data on this aspect is not available. There is evidence, however, that there are no serious problems with waterlogging except in a few small areas of low land. As noted in Annex 1, observation of the area and interviews with farmers all indicate that a high water table or fluctuations in the level have little or no effect on farming operations. The undulating topography together with a well established natural drainage system facilitates free movement and discharge of sub-surface flow. In addition the low percolation rate in the silty loam soils, 5 mm or less per day, limits the amount of water which reaches the water table, even though much of the land is flooded for several weeks each year. In any case the design of the drainage system would be for the primary purpose of relieving excess surface water and control of the groundwater level would be needed in only a few isolated areas.

Basic Data

17. The attached Tables 1 and 2 summarizes selected data for the dams and main canal systems on the four sub-projects.

October 13, 1971

ANNEX 2
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Basic Data on Dams

| Item | Dam Yang | Jang Seong | Kwang Ju | Deo Cho |
|---|---|---|---|---|
| 1. Drainage Basin | Yong San Gang | Hwang Yang Gang | Kwang Ju | Ji Seok Cheon |
| 2. Catchment Area (ha) | 6,560 | 12,280 | 4,130 | 10,470 |
| 3. Irrigable Area (ha) | 6,520 | 13,838 | 2,224 | 10,543 |
| 4. Type of Dam | Rock Fill | Earth Fill (zoned) | Earth Fill (zoned) | Earth Fill (zoned) |
| 5. Reservoir Capacity (ha-m) | 6,500/1 | 6,500/1 | 1,165 | 8,000 |
| 6. Normal Water Level (MSL) | 118.50 | 82.50 | 74.50 | 62.40 |
| 7. Height of Dam (m) | 46 | 33 | 23 | 33 |
| 8. Length of Dam (m) | 315 | 615 | 414 | 496 |
| 9. Volume ($m^3$) | 839,600 | 1,681,000 | 566,000 | 1,372,000 |
| 10. Type of Spillway | Side Channel | Morning Glory | Side Channel | Morning Glory |

/1 Will be modified during final design.

October 13, 1971

ANNEX 2
Table 2

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Basic Data on Main Canal Systems

| Item | Dam Yang | Jang Seong | Kwang Ju | Dae Cho |
|---|---|---|---|---|
| 1. Number of Canals in System | 10 | 10 | 2 | 10 |
| 2. Total Length (km) | 75.4 | 106.8 | 28.0 | 113.9 |
| 3. Unlined Earth Canal (km) | 66.4 | 74.4 | 20.7 | 96.6 |
| 4. Lined Canal (km) | 0.5 | 8.3 | 1.3 | 1.9 |
| 5. Tunnels (no.) (km) | 14/3.2 | 38/13.5 | 13/3.2 | 18/6.2 |
| 6. Siphons, Culverts, Flumes (no.)(km) | 47/5.2 | 89/10.4 | 19/2.8 | 91/9.0 |
| 7. Design Capacity at Dam ($m^3$/sec.) | 8.85 | 11.0 | 1.14 | 10.7 |

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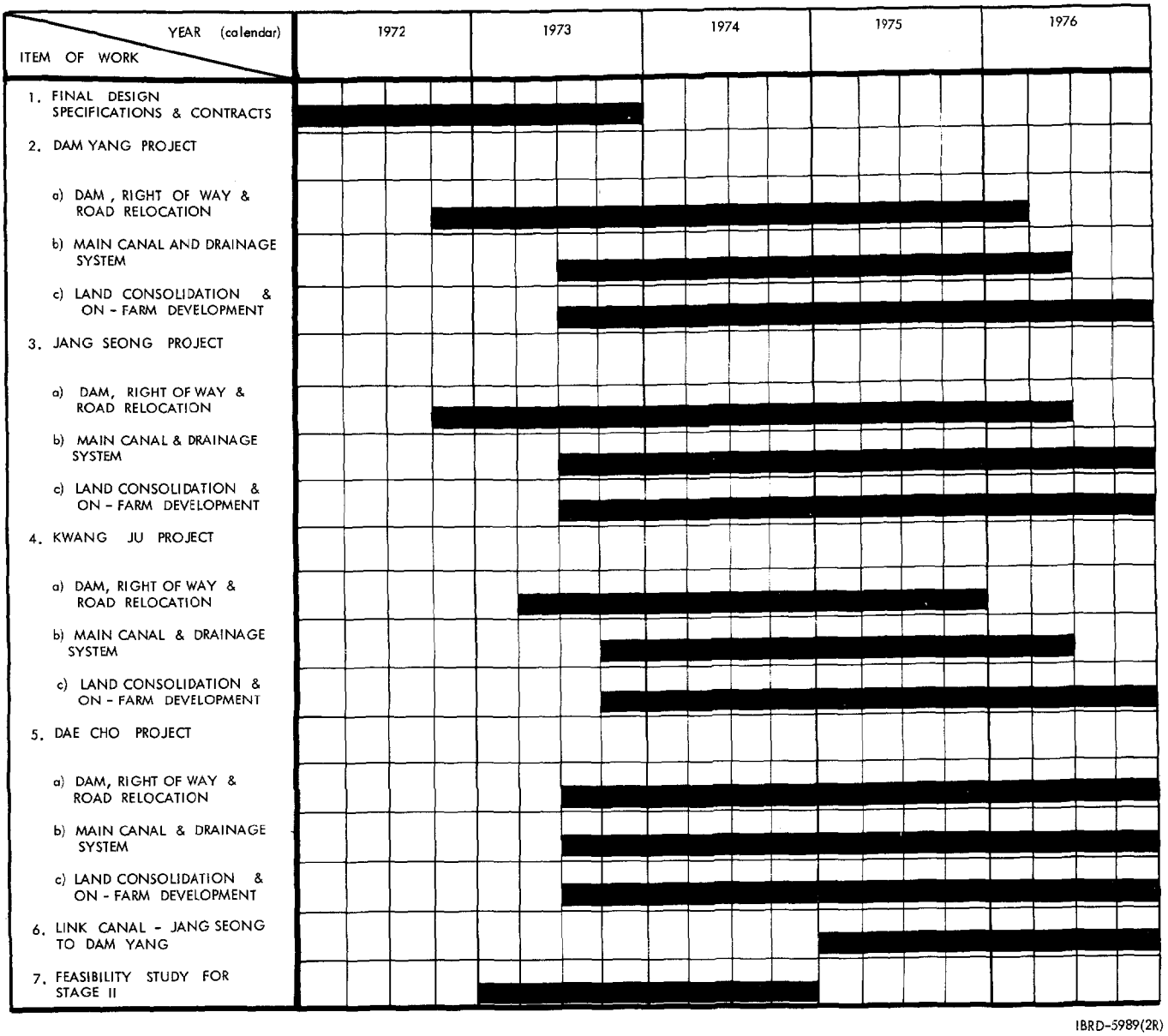
**KOREA**

# YONG SAN GANG IRRIGATION PROJECT - STAGE I

# CONSTRUCTION SCHEDULE




IBRD-5989(2R)

ANNEX 3
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Completion Dates for Major Work Items and Activities

| Subproject and Activity | Project Works: Dam | Project Works: Main Canal and Land Consolidation | Project Works: Drainage System and On-Farm Development | Begin Irrigation |
|---|---|---|---|---|
| Dam Yang | | | | |
| a) Circulate Tender Documents | 7/1/72 | 4/1/73 | 4/1/73 | |
| b) Award Contract and begin Construction | 10/1/72 | 7/1/73 | 7/1/73 | |
| c) Complete Construction | 3/30/76 | 6/30/76 | 12/30/76 | |
| d) Dam Yang Area | | | | 3/1/76 |
| e) Kwang San Area | | | | 3/1/77 |
| Jang Seong | | | | |
| a) Circulate Tender Documents | 7/1/72 | 4/1/73 | 4/1/73 | |
| b) Award Contract and begin Construction | 10/1/72 | 7/1/73 | 7/1/73 | |
| c) Complete Construction | 6/30/76 | 12/31/76 | 12/31/76 | |
| d) Jang Ham Area | | | | 3/1/76 |
| e) No An Area | | | | 3/1/77 |
| Kwang Ju | | | | |
| a) Circulate Tender Documents | 1/15/73 | 7/15/73 | 7/15/73 | |
| b) Award Contract and begin Construction | 4/1/73 | 10/1/73 | 10/1/73 | |
| c) Complete Construction | 12/31/75 | 6/30/76 | 12/31/76 | |
| d) Kwang Ju Area | | | | 3/1/76 |
| Dae Cho | | | | |
| a) Circulate Tender Documents | 4/1/73 | 4/15/73 | 4/15/73 | |
| b) Award Contract and begin Construction | 7/1/73 | 7/1/73 | 7/1 73 | |
| c) Complete Construction | 12/31/76 | 12/31/76 | 12/31/76 | |
| d) Na Ju Area | | | | 3/1/77 |
| Link Canal-Jang Seong to Dam Yang | Start construction 1/1/75 | | | Complete 12/31/76 |
| Feasibility Study for Stage II | Start study 1/1/73 | | | Complete 12/31/74 |

# KOREA

## YONG SAN GANG IRRIGATION PROJECT - STAGE I

### Water Supply, Demand, Quality and Rights

### Adequacy of Rainfall

1. Rainfall in the project area is irregular and frequently ill-timed to meet crop requirements. An examination of monthly rainfall data for the 53-year period, 1916-69, indicates that a deficiency of 25% in the average yearly rainfall could be expected once during each 3-year cycle, or duing severe droughts, in successive years for as many as 3 years. The expectancy of these yearly drought periods for 3 weeks up to a month each, which can occur anytime during the growing season, ranges from 2 to 5 years. A drought in May-June seriously retards the young plants and also causes a deficiency in river runoff for diversion and pumping. Those in July-August affect crops in the optimum growth stage and also increase irrigation demands during the hot months.

2. In the absence of irrigation the risk of drought is a major constraint which could be responsible for a low yield and make the use of fertilizer and other costly inputs ineffective. The degree of the risk is quite high in the case of rice cultivation. Rainfall data shows that drought occurred in varying degrees in 40 out of the 53 years during the transplanting period in June and the critical growth period in July-August. During these drought periods, 22 years out of the 40 show monthly rainfall being less than 25% of the crop demands. This limits the rice yield to much less than the potential which could be obtained with a full water supply.

3. In the case of crops other than rice a deficiency of rainfall in meeting the crop requirements is also evident. The magnitude of the risk is not as great as that of rice, since water requirements are considerably less. Even so, there were 36 years and 26 years out of 53 in which the rainfall was deficient during the critical growth periods of early and late crops respectively, and in about 10 of these years less than 25% of the crop requirements were met by rainfall. Moreover, the rainfall data for the 53-year period reveals several severe droughts which continued for two consecutive months. As a result total crop failure could be expected. Under these climatic conditions irrigation is essential to guarantee a firm yield from the summer crops.

4. An analysis of the drought frequencies and their magnitude is presented in Table 10.

### Water Supply

1. The project water supply would be obtained from the Yong San Gang river and its tributaries. Four independent water supply schemes, Jang Seong,

Dam Yang, Kwang Ju and Dae Cho, would be developed under the project. A dam and reservoir would be constructed in the headwaters of each of the rivers to store and regulate runoff. This would be the main supply for the 33,000 ha to be irrigated under the project. This would be supplemented by a number of existing small reservoirs or tanks on small catchments within the project area which supply a limited area with partial irrigation at present. In addition, certain other lands near the rivers obtain a partial supply by direct diversion or pumping. These several sources of supply have been taken into account in reviewing the adequacy of the project water supply for full irrigation of all land included in the project area. A classification of land in the project area according to the present water supply conditions is presented in Table 1. Under the project these lands would receive an adequate irrigation supply.

2. In the absence of long-term precipitation and runoff records in each of the river basins it was necessary to reconstitute the historical flow. This was done on the basis of 30 years of record, 1940-69, at Kwang Ju for rainfall and discharge at four gauging stations in the lower part of the basin. A computer was used to develop hypothetical flows for each 10-day period in the 30-year period and this data was the basis for the reservoir operation studies to determine the supply that would be available to the project. A review of the data derived in this manner indicated that rainfall and runoff in the basins were probably overestimated. The median of average monthly rainfall at Kwang Ju, used in the correlation, resulted in excessive amounts of rainfall in the headwater areas and a corresponding runoff coefficient exceeding 65% as compared to 50-55% measured in other basins in Korea. It was decided, therefore, to adopt a more conservative estimate and the flow data was adjusted to 70% of the original estimates. The adjusted monthly flow for the four rivers which would serve the project are shown in Tables 2 through 5. These results may be summarized as follows:

| Proposed Damsite | Average Annual Runoff ---------$Mm^3$--------- |
|---|---|
| Jang Seong | 80 |
| Dam Yang | 40 |
| Kwang Ju | 24 |
| Dae Cho | 56 |
| Total | 200 |

Inflow to Existing Reservoirs and Tanks

3. Runoff data for existing reservoirs were estimated on the basis of 50% annual runoff coefficient. The regulated supply available from these reservoirs was assessed on the basis of existing storage capacities. These estimates show that only one-third of the runoff potential available from the catchments has been used. The reservoir and tank capacities could be enlarged if it proves necessary to utilize more of the runoff. The supply data on these reservoirs are as follows:

| | $Mm^3$ |
|---|---|
| Annual Runoff | 90 |
| Total Capacity of Reservoirs | 20 |
| Usable Flow | 30 |

A breakdown of the above data for each subproject is given in Table 6.

Normal Flow in Rivers

4. The data on low flows in the rivers which supply existing projects by direct diversion or pumping were obtained from the actual measurements made during 1964-1969 at Ma Reug and Na Ju on the Yong San River; at Seon Am on the Hwang Yong tributary; and Nam Pyeong on the Dae Cho Cheon tributary. The data were extended back to 1940 using the low flow recession curve method. These flows, which provide an annual average supply of about 80 $Mm^3$, derive mainly from groundwater discharge and are adequate to serve the rice crop during the growing season. The absolute low flow condition occurs in the month of June when a supplemental supply from the reservoirs could be required. These lands would also need additional water for the winter and spring crop. The low flow data on the basis of 10-day periods are given in Table 7.

Water Requirements

5. Consumptive Use of Crops. The consumptive use of crops was estimated for climatic and rainfall conditions as experienced during the period 1940-69 by means of the Blaney and Criddle method. The crop coefficients used were based on results of experiments conducted in adjacent areas in the same region. The adopted coefficients are given in Table 8.

6. Nursery Bed -- Paddy. Water requirement for the nursery bed of rice is taken as 1,000 $m^3$/ha during May. The cultivated area required for the nursery bed is normally taken as 5% of the transplanted area.

7. Land Preparation and Transplanting -- Paddy. The analysis takes into account the supply of about 1,000 $m^3$/ha for saturating the land during land preparation and transplanting rice in June.

8. Total Requirements of Crops. The average total water requirements of crops would be as follows:

| | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | ---------- | ---------- | ---------- | ---------- | $m^3$/ha ---------- | ---------- | ---------- | ---------- | ---------- | |
| Paddy Rice | | | 250 | 2,250 | 1,750 | 2,400 | 1,350 | | | 8,000 |
| 3-month Upland | 300 | 700 | 1,000 | | | | | | | 2,000 |
| 9-month Upland (two crops) | 300 | 700 | 1,000 | 700 | 1,250 | 1,500 | 1,100 | 400 | 50 | 7,000 |

9. Effective Rainfall. With all land in the project area leveled and bordered, 75% of the daily rainfall was estimated as effective. In the case of rice, the maximum usable amount is 60 mm due to limitation imposed by the height of the borders. The data were computerized on a daily basis using field pondage carry-over system. On average, the effective rainfall would be as shown below:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm | | | | | | | | | | | | |
| Rainfall | 30 | 40 | 70 | 100 | 100 | 150 | 230 | 200 | 170 | 50 | 60 | 30 | 1,230 |
| Usable Amount | - | - | 30 | 60 | 60 | 100 | 130 | 120 | 100 | 30 | 20 | - | 650 |
| % Effectiveness (monthly basis) | - | - | 43 | 60 | 60 | 66 | 57 | 60 | 60 | 60 | 30 | | |

10. Losses and Irrigation Efficiency. Losses of irrigation water in the paddy field would be expected mainly through percolation from pondage. The percolation loss in the analysis is based on results of field investigations which indicate it could vary from 2.4 mm per day to 4.8 mm per day according to types of soil. The total field loss for upland crops was taken as 30% which is reasonable.

11. The total conveyance loss in the canal system was assumed to be 15%. The overall irrigation efficiency to be expected under the above assumptions varies within a range of 50% to 60%.

12. Municipal and Industrial Uses (M & I). The project would provide supply for M & I requirements up to the year 1990. Subsequent to this year, the increase in demands, if any, would be undertaken by other stages of the project or alternatives. The present use of water for M & I taken from the Yong San Gang River below the proposed reservoirs is reported at 38,000 $m^3$/day. The additional demands projected up to the year 1990, based on city population increases and Government's plans for new industries, would be about 210,000 $m^3$/day. The principal towns having large consumption are Kwang Ju, Mok Po and some district capital cities. These municipal consumptions are estimated on the basis of 200 liters per day (53 US gal/day) per person.

13. Total Water Requirements from Reservoirs. Table 9 summarizes the total project water requirements and those required to be drawn from the proposed reservoir as supplementary to the existing supply schemes.

## Water Quality

14. The quality of surface water resources is excellent for irrigation purposes. The river waters have been used on existing lands along the streams for generations without any bad effect. Samples taken of the Yong San River and its main tributaries show total dissolved solids of less than 100 ppm during flood and low flow periods.

Summary of Reservoir Operation Studies

15. On the basis of the average annual runoff during the 30-year period, 1940-69, the supply, about 200 $Mm^3$, would be sufficient for the project. In order to assess the adequacy on a seasonal basis and during periods of drought, reservoir operation studies were performed on the basis of the original estimates of runoff for the feasibility study and again with the adjusted runoff which was taken as 70% of the first estimates. The 30-year period includes drought years in 1943-44, 1951-52 and 1967-68 as well as average to good years, all of which gave a realistic indication of conditions under which the project would operate in the future. These studies are based on the projected cropping patterns and the irrigation demand.

16. The studies based on the lower runoff estimates indicate that reservoir storage would be sufficient to meet the irrigation requirements in 26 of the 30 years. Severe shortages in crop water requirements would occur during the drought years ranging from 19% to 20% for the 1943-44 and 1951-52 periods and up 30% for 1967-68. Such shortages would require some reduction in cropped area during these periods, with a corresponding reduction in production. It is not economic, however, to construct the dams and reservoirs to a capacity sufficient to store 100% of the runoff and to hold this storage over for several years in order to make up the shortages. The reservoirs as proposed would provide such holdover storage for 3 or 4 years but the extreme variation in inflow, as shown in Tables 2, 3, 4 and 5, can result in very short cycles, 2 to 3 years, from spill or surplus to shortage.

17. The reservoir operation studies indicated further that Dam Yang reservoir could not adequately serve the irrigable area of 8,420 ha originally designated in this subproject, whereas with an increase in the height of the dam Jang Seong reservoir would have the capability to serve more than the 12,000 ha originally proposed. It has been proposed, therefore, that the two systems be linked together, which is physically and operationally feasible, such that integrated operation of the two systems would ensure optimum use of the water resources. With this link a supplemental or full supply could be obtained from the Jang Seong system to serve the western part of the Kwang San district, about 2,000 ha. In this way water could be delivered to Kwang San from one or both systems, depending on availability and reduce the area under Dam Yang for which a full supply would be required to about 6,520 ha. Project costs include a provision of US$1.7 million for constructing the link canal. The need for this canal and the corresponding modification in the reservoirs would be reviewed by ADC and the consultants during the preparation of final designs.

18. The annual or seasonal schedule of water delivery on the project would be determined at the beginning of the two main planting seasons on the basis of the amount of water in storage at that time and an estimate of runoff during the cropping season. Operating criteria for the reservoirs would be developed, largely on the basis of actual experience, such that the farmers could be notified as to the estimated supply available during any given irrigation period. With this information the farmers could adjust the

cropped area to the supply. The criteria and the rule curve would provide that with decreasing availability, based on monthly estimates, the total annual entitlement of each farmer would be reduced accordingly, taking into account deliveries to date and the minimum amount required to finish the current crop. This would be highly important in case of prolonged drought and the need to conserve part of the stored water for the following year.

Design Floods

19. The 500-year flood probability was adopted as the design flood for each reservoir spillway. The design flood was derived on an assumed rainfall of 350 mm in a one-day storm. The resultant flood magnitudes when compared with those experienced in regions of similar climate are suitable for design purposes. For Kwang Ju dam however, the design flood appears to be underestimated by at least 4 $Mm^3$ and the dam would have to be raised by about 2.0 to provide this additional flood storage. This would be studied further before preparing the final design. The magnitudes of design floods adopted for spillway design at each dam are given below:

| | Drainage Area $km^2$ | Peak Inflow $m^3/sec$ | Flood Volume $Mm^3$ |
|---|---|---|---|
| Jang Seong | 123 | 1,040 | 36 |
| Dam Yang | 47 | 550 | 16 |
| Kwang Ju original | 41 | 400 | 8 |
| Kwang Ju adjusted | 41 | 500 | 12 |
| Dae Cho | 84 | 970 | 26 |

20. Historical flow data at Na Ju indicates flooding occurring, on the average, in about 1 out of 5 years. However, almost all of the existing irrigated lands already have flood protection embankments constructed by the Ministry of Construction. The embankments were designed for floods with a 30-year probability. Consequently, flood damages along the main river are minor. In the upper reaches, immediately downstream of the proposed dams, there would be a considerable reduction of flood stages when the dams have been built, but this would have no effect as far downstream as Na Ju and Mok Po.

Sediment Loads

21. Sediment loads transported by the rivers were computed on the basis of an annual erosion depth of 0.40 mm per year which is lower than might be expected with the storm intensity common to this region. The Yong San Gang watershed has an undisturbed natural vegetative cover which provides maximum protection against erosion. Tanks and small reservoirs built several decades ago in the river basin have retained their normal operating capacities without excessive silting. These observations indicate that the sediment storage reserved in the reservoirs would be adequate for 100 years, which is normal design criteria.

Salt Intrusion in the Mok Po Estuary

22. Construction of the reservoirs would not affect the existing salt barrier in the Mok Po estuary which is presently maintained by fresh water flow from the Yong San Gang basin. The reservoirs are located in the upper part of the river system and account for about 10% of the basins catchment area. Further, unregulated flow into the rivers below the reservoirs is sufficient to maintain the barrier and satisfy existing downstream water rights. During periods of low flow, direct diversions from the main rivers to project lands would be supplemented by reservoir releases such that no additional depletion of the normal river flow would occur.

October 13, 1971

KOREA - YONG SAN GANG IRRIGATION PROJECT - STAGE I

PROPOSED IRRIGATED AREAS AND LAND USE UNDER DIFFERENT SUPPLY SCHEMES

| Land Use | Jang Seong Scheme | | | | | Dam Yang Scheme | | | Kwang Ju Scheme | Dae Cho Scheme (Na Ju) | Total Project Area | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jang Ham | No An | Subtotal | Extension Towards Kwang San | Total | Dam Yang | Kwang San (Net) | Subtotal | | | | |
| New Irrigated Land | | | | | | | | | | | | |
| paddy | 2,562 | 1,040 | 3,602 | 800 | 4,402 | 1,169 | 1,202 | 2,371 | 1,025 1/ | 3,777 | 11,575 | |
| upland | 2,088 | 1,160 | 3,248 | 620 | 3,868 | 450 | 988 | 1,438 | 386 | 3,223 | 8,915 | |
| subtotal | 4,650 | 2,200 | 6,850 | 1,420 | 8,270 | 1,619 | 2,190 | 3,809 | 1,411 | 7,000 | 20,490 | |
| Existing Land Under Tank Supply (Without Land Consolidation At Present) | | | | | | | | | | | | |
| paddy | 2,148 | 160 | 2,308 | 480 | 2,788 | 489 | - | 489 | 143 | 1,300 | 4,720 | |
| Existing Land Under River - Run Diversion (Without Land Consolidation At Present) | | | | | | | | | | | | |
| paddy | 122 | 90 | 212 | - | 212 | 262 | - | 262 | 246 2/ | - | 720 | Proposed by Consultants |
| paddy | 1,798 | - | 1,798 | - | 1,798 | 1,112 | - | 1,112 | 424 2/ | 1,795 | 5,129 | Proposed Extension |
| subtotal | 1,920 | 90 | 2,010 | - | 2,010 | 1,374 | - | 1,374 | 670 | 1,795 | 5,849 | |
| Existing Land Under River - Run Diversion (Already Consolidated) | | | | | | | | | | | | |
| paddy | 340 | 430 | 770 | - | 770 | - | 848 | 848 | - | 448 | 2,066 | |
| subtotal for existing land | 4,408 | 680 | 5,088 | 480 | 5,568 | 1,863 | 848 | 2,711 | 813 | 3,543 | 12,635 | |
| TOTAL | 9,058 | 2,880 | 11,938 | 1,900 | 13,838 | 3,482 | 3,038 | 6,520 | 2,224 | 10,543 | 33,125 | |

ANNEX 4
Table 1

1/ 11 ha is proposed under Dam Yang Cropping Pattern
2/ 32 ha is proposed under Dam Yang Cropping Pattern

July, 1971

KOREA - YONG SAN GANG IRRIGATION PROJECT - STAGE I

ESTIMATED RUNOFF OF HWANG YONG RIVER AT JANG SEONG DAMSITE

(Drainage Area = 123 $km^2$)

Unit - $Mm^3$

(Figures in rows do not necessarily add correctly due to rounding)

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1940 | 2 | 2 | 1 | 3 | 1 | 26 | 16 | 19 | 12 | 12 | 4 | 2 | 99 |
| 41 | 1 | 1 | 4 | 2 | 7 | 17 | 22 | 19 | 13 | 3 | 3 | 2 | 94 |
| 42 | 1 | 3 | 10 | 5 | 3 | 5 | 3 | 11 | 9 | 1 | 1 | 1 | 51 |
| 43 | 0 | 0 | 3 | 3 | 2 | 5 | 21 | 2 | 9 | 5 | 3 | 1 | 55 |
| 44 | 0 | 0 | 0 | 2 | 1 | 1 | 15 | 13 | 12 | 2 | 4 | 3 | 53 |
| 45 | 0 | 0 | 13 | 1 | 2 | 15 | 6 | 16 | 19 | 17 | 2 | 3 | 95 |
| 46 | 1 | 1 | 5 | 4 | 8 | 27 | 6 | 22 | 11 | 5 | 2 | 2 | 94 |
| 47 | 3 | 0 | 1 | 4 | 4 | 8 | 30 | 7 | 5 | 2 | 1 | 4 | 70 |
| 48 | 3 | 1 | 5 | 3 | 7 | 5 | 20 | 21 | 36 | 2 | 1 | 2 | 107 |
| 49 | 2 | 2 | 4 | 2 | 4 | 1 | 24 | 10 | 5 | 2 | 2 | 1 | 59 |
| 50 | 4 | 8 | 5 | 3 | 3 | 18 | 4 | 4 | 10 | 2 | 4 | 3 | 69 |
| 51 | 3 | 2 | 3 | 2 | 4 | 4 | 3 | 4 | 3 | 8 | 5 | 3 | 43 |
| 52 | 2 | 1 | 3 | 14 | 5 | 4 | 3 | 23 | 45 | 5 | 3 | 2 | 112 |
| 53 | 0 | 1 | 7 | 1 | 5 | 25 | 14 | 3 | 5 | 2 | 2 | 6 | 72 |
| 54 | 1 | 6 | 3 | 3 | 10 | 6 | 26 | 17 | 9 | 5 | 0 | 2 | 88 |
| 55 | 0 | 2 | 2 | 1 | 0 | 1 | 25 | 18 | 6 | 1 | 3 | 1 | 59 |
| 56 | 0 | 0 | 18 | 10 | 11 | 16 | 12 | 5 | 25 | 3 | 2 | 0 | 102 |
| 57 | 2 | 2 | 0 | 6 | 5 | 7 | 19 | 20 | 1 | 1 | 8 | 5 | 77 |
| 58 | 3 | 2 | 2 | 12 | 3 | 11 | 13 | 16 | 27 | 8 | 3 | 2 | 102 |
| 59 | 2 | 8 | 5 | 7 | 5 | 2 | 8 | 7 | 16 | 1 | 5 | 4 | 69 |
| 60 | 2 | 1 | 4 | 3 | 7 | 7 | 15 | 12 | 13 | 2 | 3 | 2 | 71 |
| 61 | 2 | 1 | 14 | 7 | 7 | 6 | 19 | 19 | 13 | 9 | 7 | 2 | 105 |
| 62 | 0 | 2 | 1 | 5 | 1 | 6 | 28 | 24 | 21 | 3 | 4 | 1 | 96 |
| 63 | 1 | 1 | 2 | 6 | 12 | 40 | 21 | 2 | 1 | 2 | 2 | 2 | 91 |
| 64 | 1 | 7 | 5 | 6 | 6 | 4 | 12 | 9 | 24 | 2 | 2 | 0 | 78 |
| 65 | 2 | 4 | 1 | 2 | 4 | 4 | 39 | 9 | 3 | 1 | 8 | 2 | 80 |
| 66 | 1 | 4 | 12 | 3 | 8 | 5 | 10 | 18 | 6 | 1 | 3 | 1 | 72 |
| 67 | 2 | 2 | 5 | 3 | 1 | 9 | 7 | 1 | 1 | 1 | 9 | 2 | 42 |
| 68 | 0 | 0 | 3 | 3 | 1 | 3 | 1 | 12 | 6 | 15 | 3 | 2 | 48 |
| 69 | 4 | 6 | 2 | 13 | 10 | 2 | 12 | 21 | 38 | 3 | 1 | 3 | 115 |
| Median | 1.5 | 2.0 | 3.5 | 3.0 | 4.5 | 6.5 | 15.5 | 12.5 | 12.0 | 2 | 3 | 2 | 68 |
| Median Year - 1964 | 1 | 7 | 5 | 6 | 6 | 4 | 12 | 9 | 24 | 2 | 2 | 0 | 78 |
| % As of Annual | 1 | 9 | 6 | 8 | 8 | 6 | 15 | 12 | 31 | 2 | 2 | 0 | 100 |

July, 1971

ANNEX 4
Table 2

KOREA - YONG SAN GANG IRRIGATION PROJECT - STAGE I

ESTIMATED RUNOFF OF YONG SAN RIVER AT DAM YANG DAMSITE

(Figures in rows do not necessarily add correctly due to rounding)

Drainage Area (including Ku Rim) = 66 $km^2$

Unit - $Mm^3$

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1940 | 1 | 1 | 1 | 1 | 0 | 13 | 9 | 10 | 6 | 6 | 2 | 11 | 61 |
| 1941 | 0 | 0 | 3 | 1 | 4 | 9 | 12 | 10 | 7 | 2 | 2 | 1 | 49 |
| 1942 | 0 | 2 | 5 | 2 | 1 | 2 | 1 | 5 | 4 | 1 | - | 0 | 21 |
| 1943 | 0 | 0 | 2 | 1 | 1 | 2 | 11 | 1 | 4 | 3 | 2 | 0 | 28 |
| 1944 | 0 | 0 | 0 | 1 | 0 | 1 | 7 | 7 | 6 | 1 | 2 | 1 | 27 |
| 1945 | 0 | 0 | 7 | 1 | 1 | 8 | 3 | 8 | 10 | 9 | 1 | 2 | 49 |
| 1946 | 1 | 0 | 3 | 2 | 4 | 14 | 3 | 12 | 6 | 3 | 1 | 1 | 49 |
| 1947 | 2 | 0 | 1 | 2 | 2 | 4 | 16 | 4 | 2 | 1 | 1 | 2 | 36 |
| 1948 | 2 | 1 | 3 | 2 | 4 | 2 | 10 | 11 | 19 | 1 | 1 | 1 | 56 |
| 1949 | 1 | 1 | 2 | 1 | 2 | 1 | 12 | 5 | 2 | 1 | 1 | 1 | 30 |
| 1950 | 2 | 4 | 3 | 2 | 1 | 9 | 2 | 2 | 4 | 1 | 2 | 1 | 35 |
| 1951 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 22 |
| 1952 | 1 | 1 | 2 | 8 | 3 | 2 | 1 | 12 | 23 | 3 | 2 | 1 | 57 |
| 1953 | 0 | 1 | 4 | 0 | 3 | 13 | 7 | 2 | 2 | 1 | 1 | 3 | 37 |
| 1954 | 0 | 4 | 2 | 1 | 5 | 3 | 14 | 8 | 5 | 3 | 0 | 1 | 46 |
| 1955 | 0 | 1 | 1 | 0 | 0 | 0 | 13 | 9 | 3 | 0 | 1 | 0 | 30 |
| 1956 | 0 | 0 | 10 | 6 | 6 | 8 | 6 | 2 | 13 | 1 | 1 | 0 | 53 |
| 1957 | 1 | 1 | 0 | 3 | 2 | 3 | 10 | 10 | 0 | 1 | 4 | 3 | 40 |
| 1958 | 2 | 1 | 1 | 7 | 1 | 5 | 6 | 9 | 14 | 4 | 2 | 1 | 53 |
| 1959 | 1 | 4 | 3 | 4 | 3 | 1 | 4 | 3 | 8 | 0 | 3 | 2 | 35 |
| 1960 | 1 | 0 | 2 | 1 | 4 | 3 | 8 | 6 | 7 | 1 | 1 | 1 | 37 |
| 1961 | 1 | 1 | 8 | 4 | 4 | 3 | 10 | 10 | 6 | 5 | 3 | 1 | 54 |
| 1962 | 0 | 1 | 0 | 3 | 0 | 3 | 14 | 12 | 11 | 2 | 2 | 1 | 50 |
| 1963 | 0 | 0 | 1 | 3 | 7 | 20 | 11 | 1 | 0 | 1 | 1 | 1 | 48 |
| 1964 | 0 | 4 | 2 | 4 | 3 | 2 | 6 | 4 | 12 | 1 | 1 | 0 | 40 |
| 1965 | 1 | 2 | 1 | 1 | 2 | 2 | 20 | 4 | 1 | 0 | 4 | 1 | 41 |
| 1966 | 1 | 2 | 6 | 2 | 4 | 2 | 5 | 9 | 3 | 1 | 2 | 1 | 37 |
| 1967 | 1 | 1 | 3 | 2 | 0 | 4 | 3 | 0 | 0 | 0 | 4 | 1 | 21 |
| 1968 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 5 | 3 | 8 | 1 | 1 | 24 |
| 1969 | 2 | 3 | 1 | 7 | 5 | 1 | 6 | 11 | 20 | 1 | 0 | 2 | 60 |
| Median | 1 | 1 | 2 | 2 | 2 | 3 | 7 | 7 | 6 | 2 | 2 | 1 | 40 |
| Median Year 1964 | 0 | 4 | 2 | 4 | 3 | 2 | 6 | 4 | 12 | 1 | 1 | 0 | 40 |
| % as of Annual | 0 | 10 | 5 | 10 | 8 | 5 | 15 | 10 | 30 | 3 | 3 | 0 | 100 |

July, 1971

ANNEX 4
TABLE 3

ANNEX 4
TABLE 4

## KOREA - YONG SAN GANG IRRIGATION PROJECT - STAGE I

## ESTIMATED RUNOFF OF KWANG JU RIVER AT KWANG JU DAMSITE

Drainage Area = 41 $km^2$

Unit - $Mm^3$

(Figures in rows do not necessarily add correctly due to rounding)

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1940 | 1 | 1 | 0 | 1 | 0 | 8 | 5 | 6 | 4 | 4 | 1 | 1 | 30 |
| 1941 | 0 | 0 | 1 | 0 | 2 | 5 | 7 | 6 | 4 | 1 | 1 | 1 | 29 |
| 1942 | 0 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 3 | 0 | 0 | 0 | 15 |
| 1943 | 0 | 0 | 1 | 1 | 1 | 1 | 7 | 1 | 3 | 2 | 1 | 0 | 17 |
| 1944 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 4 | 4 | 7 | 1 | 1 | 22 |
| 1945 | 0 | 0 | 4 | 0 | 1 | 5 | 2 | 5 | 6 | 5 | 1 | 1 | 29 |
| 1946 | 0 | 0 | 2 | 1 | 3 | 8 | 2 | 7 | 3 | 2 | 1 | 1 | 29 |
| 1947 | 1 | 0 | 0 | 1 | 1 | 2 | 9 | 2 | 1 | 1 | 0 | 1 | 21 |
| 1948 | 1 | 0 | 2 | 1 | 2 | 1 | 6 | 6 | 11 | 1 | 0 | 1 | 33 |
| 1949 | 0 | 1 | 1 | 1 | 1 | 0 | 7 | 3 | 1 | 0 | 1 | 1 | 17 |
| 1950 | 1 | 2 | 2 | 1 | 1 | 6 | 1 | 1 | 3 | 1 | 4 | 1 | 21 |
| 1951 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 13 |
| 1952 | 1 | 0 | 1 | 4 | 1 | 1 | 1 | 7 | 14 | 2 | 1 | 1 | 34 |
| 1953 | 0 | 2 | 0 | 2 | 8 | 4 | 1 | 1 | 1 | 1 | 2 | 0 | 22 |
| 1954 | 0 | 2 | 1 | 1 | 3 | 2 | 8 | 5 | 3 | 1 | 0 | 1 | 27 |
| 1955 | 0 | 1 | 1 | 0 | 0 | 0 | 8 | 6 | 2 | 0 | 1 | 0 | 18 |
| 1956 | 0 | 0 | 6 | 3 | 3 | 5 | 4 | 2 | 8 | 1 | 1 | 0 | 31 |
| 1957 | 1 | 1 | 0 | 2 | 1 | 2 | 6 | 6 | 0 | 0 | 3 | 2 | 23 |
| 1958 | 1 | 0 | 1 | 4 | 1 | 3 | 4 | 5 | 8 | 3 | 1 | 1 | 31 |
| 1959 | 1 | 2 | 1 | 2 | 2 | 0 | 2 | 2 | 5 | 0 | 2 | 1 | 21 |
| 1960 | 1 | 0 | 1 | 1 | 2 | 2 | 5 | 4 | 4 | 1 | 1 | 1 | 21 |
| 1961 | 1 | 0 | 5 | 2 | 2 | 2 | 6 | 6 | 4 | 3 | 2 | 1 | 32 |
| 1962 | 0 | 1 | 0 | 2 | 1 | 2 | 9 | 7 | 7 | 1 | 1 | 0 | 29 |
| 1963 | 0 | 0 | 1 | 2 | 4 | 12 | 6 | 0 | 0 | 1 | 1 | 1 | 28 |
| 1964 | 0 | 2 | 1 | 2 | 2 | 1 | 4 | 3 | 8 | 1 | 1 | 0 | 24 |
| 1965 | 1 | 1 | 0 | 1 | 1 | 1 | 12 | 3 | 1 | 0 | 3 | 1 | 24 |
| 1966 | 0 | 1 | 4 | 1 | 2 | 2 | 3 | 5 | 2 | 0 | 1 | 0 | 22 |
| 1967 | 0 | 1 | 1 | 1 | 0 | 3 | 2 | 0 | 0 | 0 | 3 | 0 | 12 |
| 1968 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 3 | 2 | 5 | 1 | 0 | 14 |
| 1969 | 1 | 2 | 1 | 4 | 3 | 1 | 4 | 7 | 12 | 1 | 0 | 1 | 35 |
| Median | 1 | 1 | 1 | 1 | 1 | 2 | 4 | 4 | 3 | 1 | 1 | 1 | 24 |
| Median Year 1964 | 0 | 2 | 1 | 2 | 2 | 1 | 4 | 3 | 8 | 1 | 1 | 1 | 24 |
| % as of Annual | 0 | 8 | 4 | 8 | 8 | 4 | 17 | 12 | 33 | 4 | 4 | 4 | 100 |

July, 1971

ANNEX 4
TABLE 5

KOREA - YONG SAN GANG IRRIGATION PROJECT - STAGE I

ESTIMATED RUNOFF OF CHEON RIVER AT DAE CHO DAMSITE (Figures in rows do not necessarily add correctly due to rounding)

Drainage Area (including Keum Jeong) = 105 $km^2$

Unit $Mm^3$

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1940 | 1 | 1 | 1 | 2 | 1 | 19 | 12 | 15 | 9 | 9 | 3 | 2 | 74 |
| 1941 | 1 | 0 | 3 | 1 | 5 | 12 | 16 | 14 | 10 | 3 | 2 | 2 | 70 |
| 1942 | 0 | 2 | 7 | 3 | 2 | 3 | 2 | 8 | 6 | 1 | 1 | 0 | 37 |
| 1943 | 0 | 0 | 2 | 2 | 2 | 3 | 16 | 1 | 6 | 4 | 2 | 1 | 39 |
| 1944 | 0 | 0 | 0 | 1 | 0 | 1 | 10 | 10 | 9 | 1 | 3 | 2 | 38 |
| 1945 | 0 | 0 | 10 | 1 | 1 | 11 | 4 | 11 | 14 | 13 | 1 | 2 | 70 |
| 1946 | 1 | 0 | 3 | 3 | 6 | 20 | 4 | 16 | 8 | 4 | 1 | 2 | 69 |
| 1947 | 2 | 0 | 1 | 3 | 3 | 6 | 22 | 5 | 3 | 2 | 1 | 3 | 51 |
| 1948 | 3 | 1 | 4 | 2 | 5 | 3 | 14 | 15 | 27 | 2 | 1 | 2 | 79 |
| 1949 | 1 | 2 | 3 | 1 | 3 | 1 | 17 | 7 | 3 | 1 | 1 | 1 | 41 |
| 1950 | 3 | 6 | 4 | 2 | 2 | 13 | 3 | 2 | 7 | 2 | 3 | 2 | 50 |
| 1951 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 3 | 2 | 6 | 4 | 2 | 31 |
| 1952 | 2 | 1 | 2 | 11 | 4 | 3 | 3 | 17 | 33 | 4 | 2 | 1 | 82 |
| 1953 | 0 | 1 | 5 | 0 | 3 | 18 | 10 | 2 | 4 | 2 | 2 | 5 | 53 |
| 1954 | 0 | 5 | 3 | 2 | 7 | 4 | 19 | 12 | 7 | 4 | 0 | 1 | 64 |
| 1955 | 0 | 1 | 1 | 0 | 0 | 0 | 18 | 14 | 4 | 1 | 2 | 1 | 43 |
| 1956 | 0 | 0 | 13 | 8 | 8 | 11 | 9 | 4 | 19 | 2 | 1 | 0 | 75 |
| 1957 | 1 | 2 | 0 | 4 | 3 | 6 | 14 | 15 | 1 | 1 | 6 | 4 | 56 |
| 1958 | 2 | 1 | 1 | 9 | 2 | 8 | 9 | 12 | 20 | 6 | 2 | 1 | 74 |
| 1959 | 2 | 6 | 4 | 5 | 4 | 1 | 5 | 5 | 12 | 1 | 4 | 3 | 51 |
| 1960 | 2 | 0 | 3 | 2 | 5 | 5 | 11 | 9 | 9 | 2 | 2 | 1 | 51 |
| 1961 | 1 | 1 | 11 | 5 | 5 | 4 | 14 | 14 | 9 | 7 | 5 | 1 | 78 |
| 1962 | 0 | 1 | 0 | 3 | 1 | 5 | 21 | 8 | 16 | 2 | 3 | 1 | 61 |
| 1963 | 0 | 1 | 2 | 4 | 9 | 30 | 16 | 1 | 1 | 2 | 1 | 1 | 67 |
| 1964 | 1 | 5 | 4 | 4 | 4 | 2 | 8 | 7 | 18 | 1 | 2 | 0 | 56 |
| 1965 | 1 | 3 | 1 | 1 | 3 | 3 | 28 | 7 | 2 | 1 | 6 | 2 | 58 |
| 1966 | 1 | 3 | 9 | 2 | 6 | 3 | 8 | 13 | 4 | 1 | 2 | 1 | 52 |
| 1967 | 1 | 1 | 4 | 2 | 1 | 6 | 5 | 1 | 0 | 1 | 7 | 1 | 30 |
| 1968 | 0 | 0 | 2 | 2 | 1 | 2 | 0 | 8 | 5 | 11 | 2 | 1 | 34 |
| 1969 | 3 | 4 | 2 | 10 | 8 | 1 | 8 | 16 | 29 | 2 | 1 | 2 | 85 |
| Median | 1 | 1 | 3 | 2 | 3 | 4 | 10 | 10 | 9 | 2 | 2 | 2 | 49 |
| Median Year '64 | 1 | 5 | 4 | 4 | 4 | 2 | 8 | 7 | 18 | 1 | 2 | 0 | 56 |
| % as of Annual | 2 | 10 | 7 | 7 | 7 | 4 | 14 | 12 | 30 | 2 | 4 | 0 | 100 |

ANNEX 4
Table 6

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

RUNOFF DATA FOR TANK GROUPS UNDER EACH SUBSCHEME

| | Subscheme | | | | |
|---|---|---|---|---|---|
| | Jang Seong | Dam Yang | Kwang Ju | Dae Cho | Total |
| | ----------$Mm^3$---------- | | | | |
| Annual Runoff | 50 | 10 | 3 | 26 | 89 |
| Total Capacity | 13 | 2 | 0.5 | 5 | 20.5 |
| Useable Flow | 20 | 3 | 1 | 7 | 31 |

July, 1971

ANNEX 4
Table 7

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

10-Day Minimum Flow Occurring 3 Years Out of 30

Unit - $Mm^3$

| | Mar | Apr | May | June | July | Aug | Sept |
|---|---|---|---|---|---|---|---|
| Jang Seong Scheme | | | | | | | |
| Hwang Yong River at Seon Ann | 0.68 | 1.25 | 1.22 | 0.66 | 2.43 | 1.67 | 1.75 |
| Dam Yang Kwang Ju Schemes | | | | | | | |
| Yong San River at Ma Reng | 0.71 | 1.47 | 1.10 | 0.68 | 2.96 | 1.94 | 2.10 |
| Dae Cho Scheme | | | | | | | |
| Dae Cho Cheon at Nam Pyong | 0.38 | 0.84 | 0.78 | 0.38 | 1.20 | 0.75 | 0.85 |
| Yong San River at Na Ju | 3.21 | 4.42 | 5.53 | 3.70 | 8.94 | 8.61 | 9.24 |

July, 1971

ANNEX 4
Table 8

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

COMPUTATION OF WATER REQUIREMENTS - BLANEY - CRIDDLE METHOD

K-Value by Type of Crop

| Duration | | Type of Crop | | | | | |
|---|---|---|---|---|---|---|---|
| Month | 10-day Period | I | II | III | IV | V | VI |
| Mar | | | 0.39 | 0.20 | | 0.10 | 0.21 |
| Apr | | | 0.58 | 0.61 | | 0.19 | 0.41 |
| May | 1-10 | 0.70 | 0.59 | 0.79 | | 0.28 | 0.58 |
| | 11-20 | 0.70 | 0.58 | 0.80 | | 0.36 | 0.65 |
| | 21-31 | 0.70 | 0.55 | 0.76 | | 0.47 | 0.73 |
| Jun | 1-10 | 0.70 | | | | 0.61 | 0.76 |
| | 11-20 | 0.73 | | | 0.24 | 0.75 | 0.82 |
| | 21-30 | 0.74 | | | 0.33 | 0.86 | 0.85 |
| Jul | 1-10 | 0.79 | | | 0.44 | 0.94 | 0.88 |
| | 11-20 | 0.86 | | | 0.55 | 1.05 | 0.94 |
| | 21-31 | 1.05 | | | 0.67 | 1.11 | 0.96 |
| Aug | 1-10 | 1.22 | | | 0.73 | 1.11 | 0.94 |
| | 11-20 | 1.30 | | | 0.80 | 1.05 | 0.88 |
| | 21-31 | 1.30 | | | 0.84 | 0.96 | 0.83 |
| Sep | 1-10 | 1.16 | | | 0.93 | 0.83 | 0.73 |
| | 11-20 | 0.85 | | | 0.78 | 0.72 | 0.62 |
| | 21-30 | 0.70 | | | 0.67 | 0.61 | 0.53 |
| Oct | | 0.35 | | | 0.43 | 0.41 | 0.37 |
| Nov | | 0.35 | | | | | 0.21 |

Crops by Type

Type I: Rice
Type II: Barley, Garlic, Winter Onion, Rape Seed, Naked Barley
Type III: White Potato, Springtime Vegetable
Type IV: Soybean, Sweet Potato, Autumnal Vegetable, Tobacco
Type V: Red Pepper
Type VI: Fruit Tree, Fodder

October 13, 1971

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

SUMMARY OF NORMAL DIVERSION DEMANDS FOR VARIOUS SUBSCHEMES

| | Serviced Area ha | Cropped Area ha | Cropping Intensity % | Total Diversion Demands - $Mm^3$ | | | | | | | | | | | | Annual Demand | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | For Irrigation | | For M & I | TOTAL |
| | | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual | From Reservoir | From Tanks & River | From Reservoir | Irrigation and M & I |
| Jang Seong Subscheme | | | | | | | | | | | | | | | | | | | | |
| (a) New Lands | 8,270 | 14,886 | 180 | - | - | 0 | 1.0 | 6.0 | 13.0 | 8.0 | 14.0 | 8.0 | 1.0 | - | - | 51.0 | 51.0 | - | - | |
| (b) Existing Land Under Tanks | 2,788 | 5,158 | 185 | - | - | 0 | 1.0 | 3.0 | 8.0 | 5.0 | 8.0 | 5.0 | 0 | - | - | 29.0 | - | - | - | |
| Now Partially Served by Tanks | | | | - | - | 0 | 0.7 | 2.5 | 5.8 | 3.6 | 5.8 | 3.6 | 0 | - | - | 21.0 | - | 21.0 | - | |
| Supplementary Requirement | | | | - | - | 0 | 0.3 | 0.5 | 2.2 | 1.4 | 2.2 | 1.4 | 0 | - | - | 8.0 | 8.0 | - | - | |
| (c) Existing Land Under River Diversion | 2,780 | 5,143 | 185 | - | - | 0 | 1.0 | 2.0 | 8.0 | 5.0 | 8.0 | 5.0 | 0 | - | - | 29.0 | - | - | - | |
| Now Partially Served by River | | | | | | | | | | | | | | | | 28.0 | - | 28.0 | - | |
| Supplementary Requirement | | | | | | | | | | | | | | | | 1.0 | 1.0 | - | - | |
| (d) M & I and Miscellaneous | | | | | | | | | | | | | | | | 30.0 | - | - | 3.0 | |
| | | | | | | | | | | | | | | | Total: | | 60.0 | 49.0 | 3.0 | 112.0 |
| Dam Yang Subscheme | | | | | | | | | | | | | | | | | | | | |
| (a) New Lands | 3,809 | 6,856 | 180 | - | - | 0 | 0.5 | 2.8 | 6.0 | 3.7 | 6.5 | 3.7 | 0.5 | - | - | 24.0 | 24.0 | - | - | |
| (b) Existing Land Under Tanks | 489 | 904 | 185 | - | - | 0 | 0.2 | 0.4 | 1.4 | 0.9 | 1.4 | 0.9 | 0 | - | - | 5.0 | - | - | - | |
| Now Partially Served by Tanks | | | | - | - | 0 | 0.1 | 0.2 | 0.9 | 0.5 | 0.9 | 0.5 | 0 | - | - | 3.0 | - | 3.0 | - | |
| Supplementary Requirement | | | | - | - | 0 | 0.1 | 0.2 | 0.5 | 0.4 | 0.5 | 0.4 | 0 | - | - | 2.0 | 2.0 | - | - | |
| (c) Existing Land Under River Diversion | 2,222 | 4,110 | 185 | - | - | 0 | 0.8 | 1.6 | 6.4 | 4.0 | 6.4 | 4.0 | 0 | - | - | 23.0 | - | - | - | |
| Now Partially Served by River | | | | | | | | | | | | | | | | 21.0 | - | 21.0 | - | |
| Supplementary Requirement | | | | | | | | | | | | | | | | 2.0 | 2.0 | - | - | |
| (d) M & I and Miscellaneous | | | | | | | | | | | | | | | | 15.0 | - | - | 1.0 | |
| | | | | | | | | | | | | | | | Total: | | 28.0 | 24.0 | 1.0 | 53.0 |
| Kwang Ju Subscheme | | | | | | | | | | | | | | | | | | | | |
| (a) New Lands | 1,411 | 2,540 | 180 | - | - | 0 | 0.2 | 1.0 | 2.2 | 1.4 | 2.4 | 1.4 | 0.2 | - | - | 10.0 | 10.0 | - | - | |
| (b) Existing Lands | 143 | 264 | 185 | - | - | 0 | 0.1 | 0.1 | 0.4 | 0.3 | 0.4 | 0.3 | 0 | - | - | 2.0 | - | - | - | |
| Now partially served by Tanks | | | | - | - | 0 | 0 | 0 | 0.2 | 0.2 | 0.2 | 0.2 | 0 | - | - | 1.0 | - | 1.0 | - | |
| Supplementary Requirement | | | | - | - | 0 | 0 | 0 | 0.2 | 0.1 | 0.2 | 0.1 | 0 | - | - | 1.0 | 1.0 | - | - | |
| (c) Existing Land Under River Diversion | 670 | 1,240 | 185 | - | - | 0 | 0.2 | 0.5 | 1.9 | 1.2 | 1.9 | 1.2 | 0 | - | - | 7.0 | - | - | - | |
| Now Partially Served by River | | | | | | | | | | | | | | | | 5.0 | - | 5.0 | - | |
| Supplementary Requirement | | | | | | | | | | | | | | | | 2.0 | 2.0 | - | - | |
| (d) M & I and Miscellaneous | | | | | | | | | | | | | | | | 10.0 | - | - | 0.0 | |
| | | | | | | | | | | | | | | | Total: | | 13.0 | 6.0 | 0.0 | 19.0 |
| Dae Cho Subscheme | | | | | | | | | | | | | | | | | | | | |
| (a) New Land | 7,000 | 12,600 | 180 | - | - | 0 | 0.8 | 5.0 | 9.0 | 6.8 | 10.0 | 6.8 | 0.8 | - | - | 39.0 | 39.0 | - | - | |
| (b) Existing LandUnder Tanks | 1,300 | 2,405 | 185 | - | - | 0 | 0.5 | 0.9 | 3.7 | 2.3 | 3.7 | 2.3 | 0 | - | - | 13.0 | - | - | - | |
| Now Partially Served by Tanks | | | | - | - | 0 | 0.5 | 0.6 | 2.3 | 1.4 | 2.3 | 1.4 | 0 | - | - | 8.0 | - | 8.0 | - | |
| Supplementary Requirement | | | | - | - | 0 | 0 | 0.3 | 1.4 | 0.9 | 1.4 | 0.9 | 0 | - | - | 5.0 | 5.0 | - | - | |
| (c) Existing Land Under River Diversion | 2,243 | 4,149 | 185 | - | - | 0 | 0.8 | 1.6 | 6.4 | 4.0 | 6.4 | 4.0 | 0 | - | - | 23.0 | - | - | - | |
| Now Partially Served by River | | | | | | | | | | | | | | | | 22.0 | - | 22.0 | - | |
| Supplementary Requirement | | | | | | | | | | | | | | | | 1.0 | 1.0 | - | - | |
| (d) M & I and Miscellaneous | | | | | | | | | | | | | | | | 25.0 | - | - | 0.0 | |
| | | | | | | | | | | | | | | | Total: | | 45.0 | 30.0 | 0.0 | 75.0 |
| GRAND TOTAL: | | | | | | | | | | | | | | | | | 146.0 | 109.0 | 4.0 | 259.0 |

ANNEX 4
Table 9

ANNEX 4
Table 10

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Analysis of Rainfed Drought Frequency Over 53 Years (1916 - 1969)

| Crop | Critical Growth Period | Number of years between 1916-1969 in which effective rainfall accounted for less than 50% of crop water requirement during critical growth period 1/ | |
|---|---|---|---|
| | | At least one month of shortage | At least two months of shortage |
| | | (Number of Years) | |
| Upland winter | March through May | 33 | 10 |
| Upland summer | June through October | 39 | 18 |
| Rice | June through September | 50 | 39 |

1/ A 50% deficiency in water requirement in any given month during the critical growth period would generally cause a substantial reduction in yield and possibly even a total crop loss.

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Cost Estimates

Unit - US $ Million

| Item | Subprojects: Dam Yang | | | Jang Seong | | | Kwang Ju | | | Dae Cho | | | Total for Project | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local | Foreign | Total | Local | Foreign | Total | Local | Foreign | Total | Local | Foreign | Total | Total | Local Currency | Foreign Exchange |
| 1. Relocation of Road | 1.20 | - | 1.20 | 0.40 | 0.60 | 1.00 | 0.10 | 0.20 | 0.30 | 0.10 | 0.10 | 0.20 | 2.70 | 1.80 | 0.90 |
| 2. Dam, Spillway & Outlet Works | 0.80 | 2.20 | 3.00 | 0.90 | 2.40 | 3.30 | 0.40 | 0.90 | 1.30 | 0.80 | 2.00 | 2.80 | 10.40 | 2.90 | 7.50 |
| 3. Main Canal, & Laterals | 1.20 | 1.80 | 3.00 | 3.00 | 4.90 | 7.90 | 0.40 | 0.50 | 0.90 | 1.40 | 1.90 | 3.30 | 15.10 | 6.00 | 9.10 |
| 4. Main Drainage System | 0.50 | 0.40 | 0.90 | 0.60 | 0.60 | 1.20 | 0.10 | 0.10 | 0.20 | 0.60 | 0.50 | 1.10 | 3.40 | 1.80 | 1.60 |
| 5. Land Consolidation & On-Farm Development | 1.80 | 2.10 | 3.90 | 2.50 | 2.90 | 5.40 | 0.30 | 0.30 | 0.60 | 2.30 | 2.70 | 5.00 | 14.90 | 6.90 | 8.00 |
| 6. Development of New Land | 0.10 | 0.10 | 0.20 | 0.50 | 0.30 | 0.80 | 0.10 | - | 0.10 | 0.30 | 0.20 | 0.50 | 1.60 | 1.00 | 0.60 |
| 7. Acquisition of Right of Way | 1.40 | - | 1.40 | 2.30 | - | 2.30 | 0.50 | - | 0.50 | 1.90 | - | 1.90 | 6.10 | 6.10 | - |
| 8. Link Canal-Jang Seong to Dam Yang | 0.60 | 1.10 | 1.70 | - | - | - | - | - | - | - | - | - | 1.70 | 0.60 | 1.10 |
| 9. Lime Application | 0.20 | - | 0.20 | 0.20 | - | 0.20 | - | - | - | 0.20 | - | 0.20 | 0.60 | 0.60 | - |
| Sub-Total | 7.80 | 7.70 | 15.50 | 10.40 | 11.70 | 22.10 | 1.90 | 2.00 | 3.90 | 7.60 | 7.40 | 15.00 | 56.50 | 27.70 | 28.80 |
| 10. O & M during Construction | | | | | | | | | | | | | .30 | .20 | .10 |
| 11. Administration & Engineering | | | | | | | | | | | | | 5.40 | 3.00 | 2.40 |
| 12. Consultant Services & Training | | | | | | | | | | | | | 1.90 | 0.30 | 1.60 |
| Sub-Total | | | | | | | | | | | | | 64.10 | 31.20 | 32.90 |
| 13. Contingencies (Technical) | | | | | | | | | | | | | 8.20 | 3.60 | 4.60 |
| 14. Contingencies (Price Escalation) | | | | | | | | | | | | | 12.90 | 5.80 | 7.10 |
| Total | | | | | | | | | | | | | 85.20 | 40.60 | 44.60 |
| 15. Interest during Construction | | | | | | | | | | | | | 3.40 | - | 3.40 |
| Grand Total | | | | | | | | | | | | | 88.60 | 40.60 | 48.00 |

ANNEX 5
Table 1

July, 1971

ANNEX 5
Table 2

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Computation of Foreign Exchange Component

| | Estimated Total Cost | Foreign Exchange Component |
|---|---|---|
| | (US$ million) | |
| **Civil Works** | | |
| 1. Relocation of roads | 2.7 | 0.9 |
| 2. Dams, spillways and outlet works | 10.4 | 7.5 |
| 3. Main canals and laterals | 15.1 | 9.1 |
| 4. Main drainage systems | 3.4 | 1.6 |
| 5. Land consolidation and on-farm development | 14.9 | 8.0 |
| 6. Reclamation of new land | 1.6 | 0.6 |
| 7. Link canal (Jang Seong-Dam Yang) | 1.7 | 1.1 |
| 8. O & M during construction | 0.3 | 0.1 |
| 9. Engineering and administration | 5.4 | 2.4 |
| Sub-total | 55.5 | 31.3 |
| Less equipment, materials and supplies (see below) | 12.4 | 10.7 |
| Total | 43.1 | 20.6 |
| **Equipment, Materials and Supplies** | | |
| 1. Cement | 3.8 | 2.4 |
| 2. Steel (reinforcing and other) | 3.6 | 3.4 |
| 3. Lumber and timber | 4.0 | 3.9 |
| 4. Vehicles and miscellaneous | 1.0 | 1.0 |
| | 12.4 | 10.7 |
| **Consultant Services and Overseas Training** | 1.9 | 1.6 |
| **Unallocated** | | |
| 1. Contingencies | 21.1 | 11.7 |
| 2. Interest during construction | 3.4 | 3.4 |

September, 1971

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Estimated Schedule of Expenditures

| | Total Cost | 1972 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|---|
| Civil Works | (US $ million) | | | | | |
| A. Dam Yang | | | | | | |
| 1. Relocation of road | 1.2 | 0.4 | 0.8 | - | - | - |
| 2. Dam | 3.0 | 0.2 | 0.7 | 1.0 | 0.9 | 0.2 |
| 3. Main canal | 3.0 | - | 0.5 | 1.0 | 1.0 | 0.5 |
| 4. Main drainage | 0.9 | - | 0.1 | 0.3 | 0.3 | 0.2 |
| 5. Land consolidation & on-farm development | 3.9 | - | 0.6 | 1.1 | 1.1 | 1.1 |
| 6. Development of new land | 0.2 | - | - | 0.2 | - | - |
| 7. Acquisition of right-of-way | 1.4 | 0.6 | 0.4 | 0.4 | - | - |
| 8. Link canal | 1.7 | - | - | - | 0.9 | 0.8 |
| 9. Lime application | 0.2 | - | - | - | - | 0.2 |
| Sub-total | 15.5 | 1.2 | 3.1 | 4.0 | 4.2 | 3.0 |
| B. Jang Seong | | | | | | |
| 1. Relocation of road | 1.0 | 0.3 | 0.7 | - | - | - |
| 2. Dam | 3.3 | 0.2 | 0.9 | 1.0 | 1.0 | 0.2 |
| 3. Main canal | 7.9 | - | 1.4 | 2.6 | 2.6 | 1.3 |
| 4. Main drainage system | 1.2 | - | 0.2 | 0.4 | 0.4 | 0.2 |
| 5. Land consolidation & on-farm development | 5.4 | - | 0.8 | 1.5 | 1.5 | 1.6 |
| 6. Development of new land | 0.8 | - | 0.2 | 0.3 | 0.3 | - |
| 7. Acquisition of right-of-way | 2.3 | 0.9 | 0.7 | 0.7 | - | - |
| 8. Lime application | 0.2 | - | - | - | - | 0.2 |
| Sub-total | 22.1 | 1.4 | 4.9 | 6.5 | 5.8 | 3.5 |
| C. Kwang Ju | | | | | | |
| 1. Relocation of road | 0.3 | 0.1 | 0.2 | - | - | - |
| 2. Dam | 1.3 | - | 0.3 | 0.5 | 0.5 | - |
| 3. Main canal | 0.9 | - | - | 0.3 | 0.4 | 0.2 |
| 4. Main drainage system | 0.2 | - | - | 0.2 | - | - |
| 5. Land consolidation | 0.6 | - | - | 0.2 | 0.2 | 0.2 |
| 6. Development of new land | 0.1 | - | 0.1 | - | - | - |
| 7. Acquisition of right-of-way | 0.5 | 0.2 | 0.2 | 0.1 | - | - |
| 8. Lime application | - | - | - | - | - | - |
| Sub-total | 3.9 | 0.3 | 0.8 | 1.3 | 1.1 | 0.4 |
| D. Dae Cho | | | | | | |
| 1. Relocation of road | 0.2 | - | 0.2 | - | - | - |
| 2. Dam | 2.8 | - | 0.4 | 0.9 | 0.9 | 0.6 |
| 3. Main canal | 3.3 | - | 0.5 | 0.9 | 0.9 | 1.0 |
| 4. Main drainage | 1.1 | - | 0.2 | 0.3 | 0.3 | 0.3 |
| 5. Land consolidation & on-farm development | 5.0 | - | 0.7 | 1.5 | 1.4 | 1.4 |
| 6. Development of new land | 0.5 | - | 0.2 | 0.2 | 0.1 | - |
| 7. Acquisition of right-of-way | 1.9 | 0.8 | 0.6 | 0.5 | - | - |
| 8. Lime application | 0.2 | - | - | | - | 0.2 |
| Sub-total | 15.0 | 0.8 | 2.8 | 4.3 | 3.6 | 3.5 |
| Total Civil Works | 56.5 | 3.7 | 11.6 | 16.1 | 14.7 | 10.4 |
| Other Costs | | | | | | |
| E. O & M during construction | 0.3 | - | - | 0.2 | 0.1 | - |
| F. Admin., Eng., supervision | 5.4 | 0.4 | 1.1 | 1.5 | 1.4 | 1.0 |
| G. Consulting Services and Training | 1.9 | 0.3 | 0.6 | 0.6 | 0.3 | 0.1 |
| Sub-total | 64.1 | 4.4 | 13.3 | 18.4 | 16.5 | 11.5 |
| H. Contingency (Tech.) | 8.2 | 0.6 | 1.6 | 2.3 | 2.1 | 1.6 |
| Sub-total | 72.3 | 5.0 | 14.9 | 20.7 | 18.6 | 13.1 |
| I. Price contingency | 12.9 | 0.4 | 1.8 | 3.5 | 3.7 | 3.5 |
| Sub-total | 85.2 | 5.4 | 16.7 | 24.2 | 22.3 | 16.6 |
| J. Interest during construction | 3.4 | | | | | |
| Total | 88.6 | | | | | |

ANNEX 6
Table 2

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

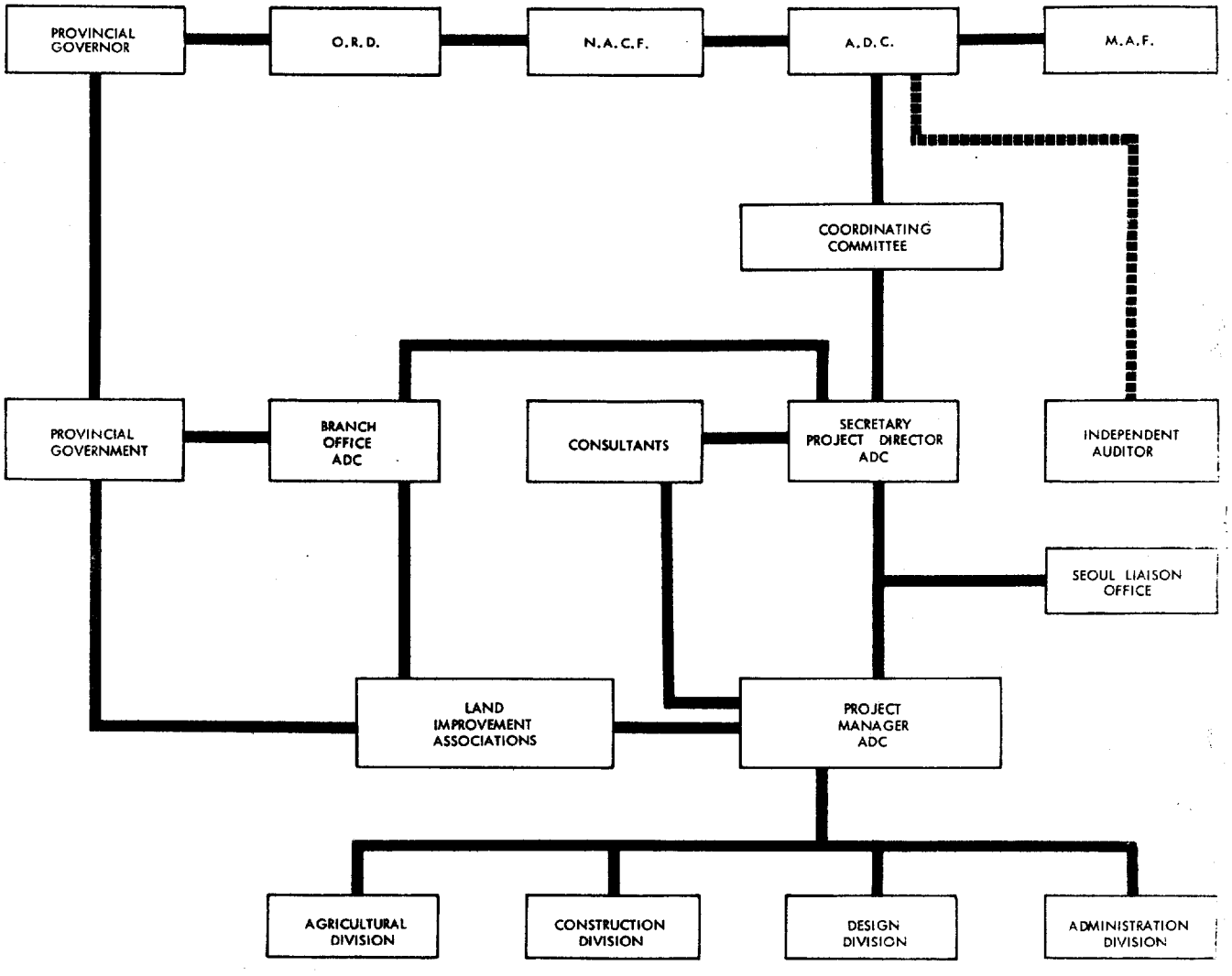
Estimated Schedule of Disbursements

| IBRD Fiscal Year and Quarter | Cumulative Disbursement at end of Quarter — US $ million | |
|---|---|---|
| | IDA | Bank |
| 1972/73 | | |
| September 30, 1972 | 0.3 | |
| December 31, 1972 | 1.0 | 0.1 |
| March 31, 1973 | 2.2 | |
| June 30, 1973 | 3.5 | 0.2 |
| 1973/74 | | |
| September 30, 1973 | 4.9 | |
| December 31, 1973 | 6.3 | 0.4 |
| March 31, 1974 | 8.9 | |
| June 30, 1974 | 11.9 | 0.5 |
| 1974/75 | | |
| September 30, 1974 | 14.4 | |
| December 31, 1974 | 15.0 | 2.1 |
| March 31, 1975 | | 5.2 |
| June 30, 1975 | | 9.4 |
| 1975/76 | | |
| September 30, 1975 | | 12.6 |
| December 31, 1975 | | 15.9 |
| March 31, 1976 | | 19.2 |
| June 30, 1976 | | 22.5 |
| 1976/77 | | |
| September 30, 1976 | | 25.5 |
| December 31, 1976 | | 28.5 |
| March 31, 1977 | | 31.0 |
| June 30, 1977 | | 33.0 |

KOREA

# YONG SAN GANG IRRIGATION PROJECT –STAGE I

# PROPOSED ORGANIZATION DURING CONSTRUCTION




IBRD - 5992(R)

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Consultant Services

1. ADC would employ a consulting firm to assist with project implementation and to prepare a feasibility study for Stage II. The consultants would assist ADC in carrying out the following activities:

(a) review of the plan proposed for the project and perform additional studies as required;

(b) preparation of final designs, specifications and cost estimates;

(c) preparation of tender documents and contracts and evaluation of bids;

(d) supervision of construction and certification of payment to contractors;

(e) inspection and acceptance of equipment and materials purchased for project use;

(f) establishing and equipping a project operation and maintenance unit and develop methods and procedures for this purpose;

(g) establish a program for applied research on agricultural practices and water use and the provision of effective extension assistance to the farmers;

(h) training of ADC staff assigned to the project;

(i) preparation of progress reports as required, and setting up project accounts; and

(j) surveys, studies and planning, leading to preparation of a feasibility study for Stage II of the project.

2. The proposed composition of the consultant team and the estimated duration of assignment are outlined below:

| Consultant Staff | Man-Years |
|---|---|
| Project Manager | 5 |
| Irrigation and Drainage Engineer | 4 |
| Hydrologist | 3 |
| Mechanical Engineer | 2 |
| Soil Scientist | 3 |
| Agricultural Economist | 3 |
| Agronomist | 3 |
| Computer Programmer | 2 |
| Engineer (Dams) | 4 |
| Specialist (Contract Administration) | 2 |
| | 31 |

3. Short-term consultants for periods of 1 to 3 months would be recruited as required to perform special work or act as senior advisors.

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YONG SAN GANG IRRIGATION PROJECT, STAGE I

Coordination of Various Agricultural Services

Present Status of Inter-Agency Coordination

1. Under the overall coordination and supervision of MAF, the various agricultural agencies operate more or less independently through their own channels of "national-provincial-county-district" offices. Their functions are described in Annex 10. Thus, ORD, through extension services, advises farmers on the use of varieties and farm inputs but it is up to the farmers to decide the amount of inputs they wish to buy and credit to obtain through the cooperatives. In other words, ORD is not directly concerned with the preparation of the farm plans on the basis of which NACF appraises farmers credit requirements. The agricultural staff employed by the LIA's have fairly close contacts with and obtain extension information from the county ORD extension officers, but are not involved in acquisition of inputs and credit by farmers, because the latter is the function of the village (Li-Dong) cooperatives.

Need for Closer Coordination in Project Implementation

2. To achieve full development in the project area within five years after the completion of construction would require a closer coordination among the various agencies than before. For overall coordination at the national level, the Project Coordinating Committee, similar to the one in existence for the Pyongtaek-Kumgang project (Loan 600-KO), would be established by MAF.

3. At the operational level, this coordination would be accomplished as follows:

(a) the agricultural staff of ADC would provide maps and inform ORD in detail on the improvements to be made in the project area on land consolidation, on-farm development, irrigation, drainage and roads; and the schedule for completion of construction in various parts of the subproject areas. It would also discuss with ORD the proposed changes in the cropping pattern for different parts of the project and the rate at which such changes should be introduced. It would then follow up and see that ORD initiates and properly carries out the necessary work;

(b) ORD would prepare new extension material designed specifically for cultivation of various crops under

irrigation and double cropping. It would also conduct demonstration programs on improved farming practices, conduct training courses for county extension officers and LIA agricultural staff, multiply and supply foundation and first multiplication seeds required by the project, and conduct extension sessions at village levels. In view of the rather short development period, the introduction of better varieties and increased inputs would need intensive promotion;

(c) since all the land would be either consolidated or terraced, provided with irrigation and drainage, and limed to the desired pH level, the physical variation among individual farms would be significantly reduced. A farm plan prepared for a given crop rotation would be applicable to a larger area than before. Responsibility for preparation of farm plans, including input requirements, would become part of the extension program. NACF and ORD would cooperate in this effort;

(d) using these farm plans, NACF would estimate the total input and credit requirement of the project and make timely arrangement for their supply;

(e) at the village level, the NACF's activities would be carried through the Li-Dong Cooperatives while ORD's activities would be assisted by the Agricultural staff of LIA's; and

(f) at all times, the agricultural staff of the ADC field office would keep in close touch with the other agencies and see that each step of the work is carried out properly. In addition, they would monitor the project farm income data which would be used to evaluate project benefits.

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# KOREA

## YONG SAN GANG IRRIGATION PROJECT - STAGE I

## Supporting Agricultural Services

### Present Status

1. The Ministry of Agriculture and Forestry (MAF) effectively supervises all agriculture services in the country. Each provincial government has an Agriculture and Forestry Bureau which administers MAF functions in the province. The main agencies which would serve the proposed project, apart from ADC, are the Office of Rural Development (ORD) and the National Agricultural Cooperative Federation (NACF).

### Research and Extension

2. ORD is in charge of research, extension, and training. The following agencies of ORD are located at its headquarters in Suwon, 25 km south of Seoul:

The ORD Headquarters;
Crop Improvement Station (breeding and agronomy of field crops);
Horticultural Research Institute (vegetables and fruits);
Institute of Plant Environment (soil survey, fertilizers, liming and pest control);
Guidance Bureau (Extension);
Training Bureau (for extension workers); and
Farm Machinery Training Center.

The research institutes and the Guidance Bureau are staffed adequately.

3. Each province has a provincial ORD which carries out local experimentation, field demonstrations, multiplication of foundation seeds and extension, and each county (GUN) has one or two branch offices. Workers in these offices form the main force of agricultural extension in Korea.

4. The experimental and demonstration results are well documented. Extension pamphlets and posters are adequate for current extension needs of rice under irrigation or rainfed and barley and other major crops under rainfed conditions. The six counties included in the project area have 206 extension workers to serve about 110,000 ha of farms, averaging about one worker to 530 ha. The existing extension system works satisfactorily as is evidenced by the relatively high yield levels even under existing rainfed conditions.

5. On existing irrigation projects the farmers are organized in Land Improvement Associations (LIA's). These associations cover about 12,500 ha in the project area and employ 27 agricultural workers who receive extension information from the county ORD but work exclusively with the LIA members.

Farmers' Organization

6. The main farmers' organization of Korea consists of multipurpose agricultural cooperatives. Almost all supplies of inputs and credit originating from Government resources are rendered through the cooperative system which also handles marketing of a number of crops. Ninety-three percent of Korean farmers are members of cooperatives.

7. The village (Li-dong) cooperatives, which may cover one to several villages, are primary societies grouped into county (Gun) Agricultural Cooperative Federations, and successively into provincial and National Agricultural Cooperative Federations (NACF). Special horticultural or livestock cooperatives are organized by vegetable/fruit growers and livestock producers.

8. Although NACF is the apex of the rural cooperatives, it actually functions as a Government trading and banking agency. The president of NACF is appointed by the President of Korea, and the managers of the provincial NACF and county cooperatives are in turn appointed by the NACF president. NACF and the cooperatives are basically farmers' organizations through which the Government effectively channels inputs and credit and assists them in marketing farm products. The cooperatives also serve the farmers to make their needs known to Government.

Supply of Seeds

9. The Jeonla Nam Do Provincial ORD multiplies foundation and first multiplication seeds, which farmers generally barter for at a 1:1 ratio, or buy at the price of common seeds. The seeds multiplied under this system include rice, barley, wheat, soybean, and sweet potatoes. The Provincial Government is responsible for distributing the rice and barley seeds through the NACF/Cooperative network. NACF directly buys and supplies a wide range of other seeds, while farmers supplement seeds not provided by Government. So far, seed supply has not been a serious constraint to crop production.

Supply of Other Inputs

10. Fertilizers are supplied solely by NACF. MAF estimates annual demand of fertilizers for each province; NACF advances funds for their purchase (either from local factories or import) and then contracts the Korean Transportation Corporation to ship them to warehouses of the County (Gun) NACF. In the six counties covering the project area NACF has a total of 142 warehouses with a total capacity of 25,000 tons. NACF also rents private warehouses when needed. The average distance farmers have to

travel to the nearest NACF warehouse is about 2 km. About half of the fertilizers are sold for cash and the other half on short term credit basis. Farmers can buy unlimited amounts. Pesticides are bought from either the County NACF warehouse on a cash basis or from private dealers who operate small stores in the villages. The system of supplying lime is described in Annex 1.

11. In 1970, the Jeonla Nam Do Provincial NACF through its 21 county offices supplied a total of Won 5,900 million worth of fertilizers and lime, Won 815 million of agricultural chemicals, Won 304 million of farm implements, Won 185 million of seeds (Including potatoes), Won 236 million of farm material, and Won 76 million of miscellaneous items, for a total value of about Won 7,500 million. Additional amounts supplied by the six county NACF's are not known but it may safely be said that the system of supplying farm inputs has been generally effective.

Supply of Credit

12. Agricultural credit is also channeled through NACF. The two major sources are NACF's own resources, which include farmers' deposits with cooperatives and borrowings from the Bank of Korea, and Government loans for specific programs.

13. NACF's short term loans are for one year at 15% interest per annum, while medium term loans are for 1-5 years at 9% interest per annum. The maximum amount that a family can borrow without security is determined by NACF appraisal against individual applications, but the absolute maximum is Won 300,000 for short term loans and Won 75,000 for medium term loans. Security in the form of fixed assets is required for amounts beyond these limits. For loans without security, a guarantee from other farmers (group guarantee) is required.

14. NACF loans in Jeonla Nam Do Province, including those to farmers and cooperatives or agencies, have been increasing rapidly in recent years:

| Year | Short Term | Medium Term | Total | Annual Growth 1968 = 100 |
|---|---|---|---|---|
| | Million Won | | | |
| 1968 | 3,099 | 1,040 | 4,139 | 100 |
| 1969 | 3,167 | 3,797 | 6,964 | 168 |
| 1970 | 4,386 | 4,342 | 8,728 | 211 |
| 1971 (plan) | 4,959 | 5,521 | 10,480 | 253 |

15. NACF's short term loans meet about 50% of farmers' needs. The balance is provided by private money lenders at 40-50% interest per annum. In 1969 NACF provided about Won 8,000 of short term credit per household and about Won 5,500 worth of fertilizers on credit, or a total of Won 13,500 per household. This is equivalent to about 27% of the production cost of an average household (about Won 50,000). Moreover, because of the overall shortage of funds, small farmers are usually left out because of their failure to put up security or obtain group guarantees.

16. The net amount of overdue NACF loans for Korea has increased from Won 3,285 million in 1965 to Won 7,725 million in 1969, but the percentage of total outstanding loans overdue has decreased from 15.7% to 9.2% during the same period. The debt considered uncollectable has increased from Won 3 million to Won 10 million during this period, but as a percentage of total outstanding loans it has been reduced from 0.016% to 0.012%. The percentage of defaulting borrowers, however, is higher than that of default in terms of money, since the higher rate is among farmers who received small loans.

## Improvements Needed for Project Implementation

### Research

17. The current research program of ORD has two major shortcomings from the viewpoint of project implementation:

(a) experiments and extension material on irrigation of upland crops are almost totally lacking, although some farmers in the project area have individually accumulated experience in irrigating vegetables and fruit trees with shallow wells; and

(b) experimental data on mechanized farming, either with tractors or with power tillers are limited and inadequate.

18. Under the project ORD would conduct irrigation experiments on upland crops. The Guidance Bureau of ORD would also conduct a survey of the existing irrigation practices of farmers in order to supplement the experimental results. Trials on the use of tractors, power tillers and equipment would be continued at ORD's headquarters in Suwon, and would be supplemented by ADC's farm machinery program under the Pyongtaek-Kumgang project (600-KO).

### Extension

19. The number of ORD extension workers in the project area would be increased from 60 to 125 by 1976. This would bring the ratio of ORD workers to about 1 for each 260 ha. Moreover, when the project construction is completed, the entire 33,000 ha would be organized into LIA's.

Assuming the existing ratio of agricultural workers to cultivated land is maintained, the LIA's would have about 70 agricultural workers in the future, as compared to 27 workers for 12,600 ha at present.

20. New extension work items to be emphasized would include irrigation and drainage practices; proper dosage of lime; use of power tillers, power sprayers, semiautomatic thresher and farm equipment; and production of high value vegetables and fruits. New extension material would be prepared by ORD specifically for irrigated double cropping on consolidated paddies and terraced uplands. ADC agricultural staff would keep ORD informed on the progress of project implementation and the needs for extension assistance. ORD would conduct training courses for extension workers and LIA's agricultural staff in the project area.

21. As under Loan 600-KO, a 10-year plan for agricultural development and the associated extension program on the project would be prepared by ADC.

Seeds

22. A feasibility study for a seed project for Korea is being prepared by consultants under Loan 600-KO. When the new seed multiplication and distribution system is established, it would be applied in the Yong San Gang project area, among others.

Other Inputs

23. Higher rates of application of fertilizers and pesticides than those in present use would be tested and demonstrated to the farmers. ADC agricultural staff would work closely with ORD to coordinate the demonstration and extension work and with NACF to ensure the timely supply of inputs.

Credit

24. The average production cost per household under the project is estimated to increase to about 2.5 times the present level or from Won 50,000 to about Won 125,000. If the same ratio of production cost to NACF borrowing (27%) is maintained, each household would need an average loan of Won 33,750. The annual short term credit need of the 45,000 farm families in the project area would thus amount to about Won 1,500 million. By comparison, loans granted for all purposes by NACF and its member cooperatives in Korea during 1969, including short and medium term credit to farmers, cooperatives, and agencies totalled Won 152,000 million.

Power Tillers and Equipment

25. The project area has an extremely low population of draft animals, averaging one animal to 5 ha. As a result of rapid migration of rural people to cities and the increase in farm labor wages, mechanization

is making rapid inroads into rural Korea. In the six project counties, farmers now own 4,500 power tillers, 880 motor sprayers, 1,270 motor threshers and about 1,000 trailers. NACF provides medium term loans to farmers for farm machinery and equipment, but the available funds have so far been unable to cope with the growing need. Government announced a mechanization loan program in May 1971 under which NACF would receive funds to finance the purchase of power tillers and other farm machinery, with a 24% down payment and a five-year loan at 9% interest per annum to cover the remaining cost. The entire program is estimated to cost Won 18.5 billion (about US$60 million), including US$15 million yet to be arranged in foreign loans.

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YONG SAN GANG IRRIGATION PROJECT - STAGE I

Marketing

Present Marketing System

1. Korea has basically a free marketing system for agricultural products, although MAF operates, through the Provincial Government and NACF, an Agricultural and Fishery Price Stabilization Fund to support farm prices of foodgrains and a few other crops. Cooperatives, under NACF management, play an active role in marketing vegetables and fruits to distributors in the large cities.

2. Under the Price Stabilization Fund program, rice, barley and wheat are the responsibility of the Provincial Government, but the purchase is done through NACF and its cooperatives. After the purchase, the County office stores the grain in warehouses owned by NACF, private traders and Korean Transportation Corporation. The total amount of summer grain (mainly rice) and fall grain (barley and wheat) purchased and collected by Government in Jeonla Nam Do Province amounted to 75,600 tons and 77,000 tons respectively in 1969. This equals about 11% of the province's rice production and 12% of the barley production in that year.

3. NACF's purchases under the program throughout Korea in 1970 amounted to 4,800 tons of rape seeds, 2,800 tons of malt barley, 1,200 tons of flax, 60 tons of ramie and 190,000 tons of sweet potato. The total cost of these purchases was at a total cost of W 5,638 million.

4. All NACF purchases were made through the cooperative markets. Each county has 10 to 20 such markets in several districts (Myon), each district having one or two markets operated by the cooperatives under the supervision of the county NACF staff. The markets are open for business once every five days. Farmers send their products to the markets and are free to sell to private traders with payment being made, at times, several days later. If they sell to NACF at the fixed prices they receive cash payment immediately. NACF stores the products in its warehouses while sales arrangements are being made and later sells rape seed to private oil mills, sweet potatoes to wine factories, malt barley to beer factories, and fiber crops to textile or cordage mills.

5. Vegetables and fruits are brought to the same markets. NACF advances 80% of the estimated price and auctions the produce to wholesalers immediately. Products in the project area are bought mainly by wholesalers from Seoul, Pusan and Kwanju cities. Accounts are cleared with member farmers after the sales. The NACF headquarters in Seoul, through its Marketing Survey Department, has daily telephone communication with its offices in

other large cities, e.g. Pusan, Kwanju, Ta-Ju and Ta-Jean, which, in turn, monitor daily prices and the supply situation of the perishable products through the cooperative markets managed by various county NACF's.

6. Some large wholesalers buy fruits and vegetables in the field before harvest and advance partial payment to farmers. Later they harvest the crop themselves and clear the final account with farmers. About 40% of the horticultural crops are bought under this arrangement and 60% through the cooperatives.

7. Two cold storage warehouses, mainly for onions and garlic, have been built in recent years in Mu An County by the County Office and an Agricultural and Fishery Community Development Association. NACF has no cold storage facilities at present, but has plans to build one in the project area in the near future. The lack of cold storage forces NACF to auction off all perishable products at each market day. The numerous cooperative markets already in active operation provide a strong base for receiving and marketing the increased amount of high value crops to be produced in the project area in the future.

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# KOREA

## YONG SAN GANG IRRIGATION PROJECT, STAGE I

## Present and Projected Cropping Patterns

### Present Cropping Pattern

1. In 1969 Jeonla Nam Do Province produced 18% of Korea's total rice crop, 25% of barley, 50% of rape seed, 27% of potato, and almost the entire crop of mat rush (for making straw mats). In comparison with provinces further north, it has a milder winter and a longer growing season. This combination gives the area a good potential for double cropping and crop diversification. On the other hand, the Province has the highest drought frequency and is among the highest in soil acidity in the nation.

2. Frequent droughts cause large fluctuations in the rainfed rice area harvested each year. This is also the case in areas presently receiving partial irrigation. Barley is the main winter crop grown under rainfed conditions. The shortage of both man and animal labor further limits farmers from growing labor intensive crops.

3. The typical cropping pattern is rice in the summer, followed by barley in the winter on paddy land, and assorted summer crops followed by barley on upland. Among the upland summer crops, soybean has the largest area, followed by sweet potatoes. Orchards have limited areas at present and are found mostly on the south side of hills with gentle slopes.

4. The upland in the project area is fully double-cropped or planted to orchards, bamboo, mulberries or fodder crops. About one-third of the paddy fields are fallow each year. The overall cropping intensity is 160%. The potential for crop diversification is demonstrated by the wide range of high value vegetable crops being grown in limited areas where farmers have an irrigation supply.

### Present Crop Yield

5. The large unplanted or unharvested area of paddy depresses the average rice yield per ha. When calculated on the basis of total paddy land area, instead of harvested area, the present rice yield (white) in the project area is 2.4 tons per ha. for the rainfed fields and 2.8 tons per ha. for the partially irrigated fields.

6. The present yields of barley and other upland crops are limited by both the lack of irrigation and the high soil acidity. Large variations in crop growth may be seen in fields with better or less favorable natural soil moisture conditions due to differences in topography, and presumably

also to differences in soil acidity. For barley and most other winter and spring upland crops, the yield is largely dependent on moisture conditions in April and May. Farmers who use lime and irrigate their land during the dry spring months report doubling or even tripling of yields. Present crop yield levels are given in Table 1.

7. New improved varieties would continue to be extended, and use of fertilizers and pesticides further increased, but the resultant yield increment would not be as great as in other parts of Asia, because the use of improved varieties and agricultural chemicals is already prevalent among Korean farmers.

Future Cropping Pattern

8. Under the project, the element of drought would be removed from the rice crop. Supplementary irrigation would be supplied to the fall/spring planted upland crops, as well as to the summer crops on the upland. Irrigation to individual land parcels and improvement of drainage would be made possible by land consolidation and on-farm development. Soil acidity would be corrected by liming. Labor and animal shortage would be met by use of power tillers, sprayers and threshers.

9. With the above improvements, the following changes in cropping pattern in the project area are projected:

(a) the irrigated rice area would be increased from 12,600 ha to 24,000 ha;

(b) the barley area would be reduced from 20,000 ha to 13,000 ha;

(c) other high value winter crops on paddy and upland fields would be increased to about 17,000 ha. Among these crops, the important ones include garlic, onion, red pepper, potatoes, Chinese cabbage and mat rush;

(d) orchard and other perennial crops would be increased from 450 ha to 1,200 ha;

(e) 2,250 ha of woodland (pine) would be reclaimed for upland crops, orchards and pasture; and

(f) the overall crop intensity would be increased to 182%.

Future Crop Yield

10. With full irrigation and increased use of inputs it is estimated the rice yield would increase to 4.2 tons per ha at full development. This yield level is projected on the following basis:

(a) yields of 4.5 tons per ha are common in experiments, field trials and in numerous demonstrations on farmers' fields with existing varieties, when supplementary irrigation is provided, together with proper rates of fertilizer and pesticides;

(b) a 20% reduction from yields obtained in trial and demonstration field is applied for projecting yield levels obtainable by farmers under present conditions. This reduces the yield level to 3.6 tons per ha; and

(c) an increase of 3% per year or a total of 15% over a five-year period due to the adoption of the following additional improvements:

(i) introduction of new varieties with greater resistance to lodging and diseases;

(ii) deeper plowing by use of power tillers;

(iii) improvement of drainage; and

(iv) proper dosage of lime.

11. Irrigation research for upland crops has not been conducted in Korea. Future yield projections for upland crops are based on yield levels already obtained by farmers on fields with favorable natural soil moisture conditions (barley), or on fields irrigated by shallow wells (vegetables and fruits). Yield levels of the same crops in Japan and Taiwan under irrigation were also used as a reference. The projected cropping pattern and estimated yields with full development are presented in Table 2.

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YONG SAN GANG IRRIGATION PROJECT - STAGE I

Present Cropping Pattern 1/

| | Crop Area (ha) | Yield (ton/ha) | Farm-Gate Prices (won/ton) | Gross Value of Production | Production Costs | Net Value of Production | Net Returns from Project Area (won million) |
|---|---|---|---|---|---|---|---|
| | | | | (won '000/ha) | | | |
| Rice: | | | | | | | |
| Partial Irrigation | 12,600 | 2.8 | 94,000<br>(56,000) | 263<br>(157) | 100 | 163<br>(57) | 2,054<br>(718) |
| Rainfed | 11,600 | 2.4 | 94,000<br>(56,000) | 226<br>(134) | 89 | 137<br>(45) | 1,589<br>(522) |
| Barley | 20,000 | 2.2 | 44,000<br>(22,000) | 97<br>(48) | 79 | 18<br>(-31) | 360<br>(-620) |
| Chinese Cabbage | 1,600 | 12.0 | 15,000 | 180 | 124 | 56 | 90 |
| Sweet Potato | 1,500 | 15.0 | 15,000 | 225 | 84 | 141 | 212 |
| White Potato | 800 | 10.0 | 17,000 | 170 | 101 | 69 | 55 |
| Rape Seed | 600 | 1.3 | 65,000 | 85 | 69 | 16 | 10 |
| Others 2/ | 1,800 | - | - | - | - | 88 | 158 |
| Total | 50,500 | | | | | | 4,528<br>(1,145) |
| Cropping Intensity 3/ | 163% | | | | | | |

1/ All prices expressed at 1971 market values; figures in parentheses indicate adjustments made for the purpose of economic analysis. (See Annex 14 for details).
2/ Mainly soybeans, orchards, vegetables and fodder crops
3/ Based on a net area of 31,000 ha which excludes about 2,000 ha of forest land

ANNEX 12
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Projected Cropping Pattern 1/

| | Crop Area (ha) | Yield (ton/ha) | Farm-Gate Prices (won/ton) | Gross Value of Production (Won '000/ha) | Production Costs 2/ (Won '000/ha) | Net Value of Production (Won '000/ha) | Net Returns from Project Area (Won million) |
|---|---|---|---|---|---|---|---|
| Rice | 24,000 | 4.2 | 94,000 (56,000) | 395 (235) | 134 | 261 (101) | 6,264 (2,424) |
| Barley | 13,000 | 3.0 | 44,000 (22,000) | 132 (66) | 90 | 42 (-24) | 546 (-312) |
| White Potato | 6,000 | 16.0 | 17,000 | 272 | 160 | 112 | 672 |
| Sweet Potato | 4,000 | 23.0 | 15,000 | 345 | 139 | 206 | 824 |
| Chinese Cabbage | 3,000 | 28.0 | 15,000 | 420 | 216 | 204 | 612 |
| Rape Seed | 2,000 | 2.5 | 65,000 | 163 | 100 | 63 | 126 |
| Orchards | 1,200 | - | - | 866 | 348 | 518 | 622 |
| Garlic | 1,200 | 9.0 | 165,000 | 1,485 | 300 | 1,185 | 1,422 |
| Onion | 600 | 30.0 | 35,000 | 1,050 | 214 | 836 | 502 |
| Others 3/ | 5,000 | - | - | - | - | - | 633 |
| Total | 60,000 | | | | | | 12,223 (7,525) |

Cropping Intensity 4/ 182%

1/ All prices expressed at 1971 market values; figures in parentheses indicate adjustments made for the purpose of economic analysis (see Annex 14 for details)
2/ For details see Table 3 in Annex 12.
3/ Mainly soybean, red pepper, vegetables and fodder crops
4/ Based on a net area of 33,000 ha which includes 2,000 ha of cleared forest land

ANNEX 12
Table 2

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Production Costs at Full Development

| | Seeds | Fertilizers | Pesticides | Machinery 1/ | Labor 2/ | Others 3/ | Total | Total exc. Labor |
|---|---|---|---|---|---|---|---|---|
| | (won/ha) | | | | | | | |
| Rice | 2,300 | 11,400 | 6,000 | 57,000 | 43,000 | 14,000 | 133,700 | 90,700 |
| Barley | 2,900 | 10,000 | 3,300 | 30,000 | 33,000 | 11,000 | 90,200 | 57,200 |
| White Potato | 30,500 | 8,800 | 2,200 | 54,000 | 49,000 | 16,000 | 160,500 | 111,500 |
| Sweet Potato | 7,000 | 11,000 | 1,100 | 54,000 | 49,000 | 17,000 | 139,100 | 90,100 |
| Chinese Cabbage | 42,000 | 33,000 | 5,500 | 63,000 | 55,000 | 17,000 | 215,500 | 160,500 |
| Rape Seed | 500 | 9,900 | 4,400 | 22,000 | 48,000 | 14,000 | 98,800 | 50,800 |
| Orchards 4/ | - | 15,400 | 41,800 | 66,000 | 147,000 | 78,000 | 348,200 | 201,200 |
| Garlic | 120,700 | 14,100 | 2,200 | 63,000 | 78,000 | 24,000 | 302,000 | 224,000 |
| Onion | 22,000 | 15,400 | 4,400 | 63,000 | 86,000 | 23,000 | 213,800 | 127,800 |

1/ Based on the use of power tillers for land preparation and transportation, semi-automatic threshers, power sprayers and dusters.

2/ Labor costs consist of both family and hired labor. Based on existing pattern it was assumed that half the labor requirement would be provided by male workers at the rate of won 650 per 10 hours working day and the balance by female workers at won 430 per day or an average rate of won 540 per working day. All expenses for machine operators have been included under machinery costs.

3/ Mainly materials, farm implements, lime and farm manure.

4/ Based on the weighted average of an equal area of pears, peaches and grapes. Other costs include farm manure won 11,000; materials won 37,000; farm implements won 16,000; lime won 4,000 and misc. won 6,000.

ANNEX 12
Table 3

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Farm Budget for Typical 0.3 ha Farms

| Crop | Present Conditions | | | | Full Development | | | |
|---|---|---|---|---|---|---|---|---|
| | Area | Production | Gross Value of Production | Production Costs 1/ | Area | Production | Gross Value of Production | Production Costs 1/ |
| | (ha) | (Kg) | (Won) | | (ha) | (Kg) | (Won) | |
| Rice | 0.22 | 572 | 53,800 | 6,000 | 0.22 | 924 | 86,800 | 16,100 |
| Barley | 0.20 | 440 | 19,400 | 6,400 | 0.12 | 360 | 15,800 | 4,300 |
| Miscellaneous vegetables | 0.04 | 500 | 7,700 | 1,800 | 0.12 | 2,560 | 40,400 | 13,300 |
| Others | 0.04 | - | 7,100 | 1,500 | 0.10 | - | 56,500 | 14,600 |
| | 0.50 | | 88,000 | 15,700 | 0.56 | | 199,500 | 48,300 |

| | Present Conditions (Won) | Full Development (Won) |
|---|---|---|
| Gross value of production | 88,000 | 199,500 |
| Less production costs | 15,700 | 48,300 |
| Less other expenditures 2/ | 3,000 | 7,350 |
| Farm Income | 69,300 | 143,850 |
| Less project charges 3/ | 2,300 | 11,850 |
| Net Income from Farming | 67,000 | 132,000 |
| plus income from non-farming activities 4/ | 68,000 | 134,000 |
| Total Farm Income | 135,000 | 266,000 |

Incremental Farm Income Won 131,000

1/ Excluding the cost of family labor which at present amounts to about 84% of total labor requirements. The number of man-days to be contributed by family labor at full development was assumed to remain at the present level and all increases in labor requirements to be met either through hiring additional labor or mechanization.

2/ Under present conditions, mainly taxes and public charges (Won 1,400) and interest on short term loans (Won 1,600).

3/ Project charges under present conditions represent the pro-rated cost of operation, maintenance and capital recovery in the partially irrigated lands.

4/ Based on country wide income projections, earning from non-farming activities were assumed to increase at 7% per year.

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Farm Budget for Typical 0.7 ha Farms

| Crop | Present Conditions | | | | Full Development | | | |
|---|---|---|---|---|---|---|---|---|
| | Area | Production | Gross Value of Production | Production Costs 1/ | Area | Production | Gross Value of Production | Production Costs 1/ |
| | (ha) | (Kg) | (Won) | | (ha) | (Kg) | (Won) | |
| Rice | 0.52 | 1,350 | 126,900 | 17,300 | 0.52 | 2,180 | 204,900 | 41,200 |
| Barley | 0.46 | 1,010 | 44,400 | 16,800 | 0.27 | 810 | 35,600 | 10,700 |
| Miscellaneous vegetables | 0.10 | 1,260 | 19,200 | 5,200 | 0.27 | 5,690 | 90,200 | 31,100 |
| Others | 0.08 | - | 14,200 | 3,500 | 0.23 | - | 130,000 | 34,800 |
| | 1.16 | | 204,700 | 42,800 | 1.29 | | 460,700 | 117,800 |

| | Present Conditions (Won) | Full Development (Won) |
|---|---|---|
| Gross value of production | 204,700 | 460,700 |
| Less production costs | 42,800 | 117,800 |
| Less other expenditure 2/ | 5,300 | 10,500 |
| Farm Income | 156,600 | 332,400 |
| Less project charges 3/ | 5,600 | 27,400 |
| Net Income from Farming | 151,000 | 305,000 |
| plus Income from Non-farming Activities 4/ | 46,000 | 90,000 |
| Total Farm Income | 197,000 | 395,000 |

Incremental Farm Income Won 198,000

1/ Excluding the cost of family labor which at present amounts to about 82% of total labor requirements. The number of man-days to be contributed by family labor at full development was assumed to remain at the present level and all increases in labor requirements to be met either through hiring additional labor or mechanization.

2/ Under present conditions, mainly taxes and public charges (Won 3,000) and interest on short term loans (Won 2,300).

3/ Project charges under present conditions represent the pro-rated cost of operation, maintenance and capital recovery in the partially irrigated lands.

4/ Based on country wide income projections, earning from non-farming activities were assumed to increase at 7% per year.

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Farm Budget for Typical 1.5 ha Farms

| Crop | Present Conditions | | | | Full Development | | | |
|---|---|---|---|---|---|---|---|---|
| | Area | Production | Gross Value of Production | Production Costs 1/ | Area | Production | Gross Value of Production | Production Costs 1/ |
| | (ha) | (Kg) | (Won) | | (ha) | (Kg) | (Won) | |
| Rice | 1.1 | 2,860 | 268,800 | 45,700 | 1.1 | 4,620 | 434,300 | 96,600 |
| Barley | 1.0 | 2,200 | 96,800 | 43,300 | 0.6 | 1,800 | 79,200 | 27,700 |
| Miscellaneous Vegetables | 0.2 | 2,500 | 38,100 | 11,900 | 0.7 | 15,150 | 238,700 | 89,000 |
| Others | 0.1 | - | 17,800 | 5,000 | 0.3 | - | 170,000 | 47,700 |
| | 2.4 | | 421,500 | 105,900 | 2.7 | | 922,200 | 261,000 |

| | Present Conditions (Won) | Full Development (Won) |
|---|---|---|
| Gross Value of Production | 421,500 | 922,200 |
| Less Production Costs | 105,900 | 261,000 |
| Less Other Expenditures 2/ | 10,100 | 24,700 |
| Farm Income | 305,500 | 636,500 |
| Less Project Charges 3/ | 11,500 | 58,500 |
| Net Income from Farming | 294,000 | 578,000 |
| plus income from non-farming activities 4/ | 46,000 | 90,000 |
| Total Farm Income | 340,000 | 668,000 |

Incremental Farm Income Won 328,000

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1/ Excluding the cost of family labor which at present amounts to about 70% of total labor requirements. The number of man-days to be contributed by family labor at full development was assumed to remain at the present level and all increases in labor requirements to be met either through hiring additional labor or mechanization.

2/ Under present conditions, mainly taxes and public charges (Won 7,400) and interest on short term loans (Won 2,700).

3/ Project charges under present conditions represent the pro-rated cost of operation, maintenance and capital recovery in the partially irrigated lands.

4/ Based on country wide income projections, earning from non-farming activities were assumed to increase at 7% per year.

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

Farm Budget for Typical 3.0 ha Farms

| Crop | Present Conditions | | | | Full Development | | | |
|---|---|---|---|---|---|---|---|---|
| | Area | Production | Gross Value of Production | Production Costs 1/ | Area | Production | Gross Value of Production | Production Costs 1/ |
| | (ha) | (Kg) | (Won) | | (ha) | (Kg) | (Won) | |
| Rice | 2.2 | 5,720 | 537,700 | 128,800 | 2.2 | 9,420 | 868,600 | 121,400 |
| Barley | 2.0 | 4,400 | 193,600 | 114,900 | 1.2 | 3,600 | 158,400 | 71,600 |
| Miscellaneous vegetables | 0.4 | 5,000 | 76,300 | 30,600 | 1.2 | 25,600 | 404,600 | 170,500 |
| Others | 0.3 | - | 53,400 | 19,800 | 0.9 | - | 509,000 | 158,200 |
| | 4.9 | | 861,000 | 294,100 | 5.5 | | 1,940,600 | 521,700 |

| | Present Conditions (Won) | Full Development (Won) |
|---|---|---|
| Gross value of production | 861,000 | 1,940,600 |
| Less production costs | 294,100 | 521,700 |
| Less other expenditures 2/ | 18,000 | 30,400 |
| Farm Income | 548,900 | 1,388,500 |
| Less Project charges 3/ | 22,900 | 116,500 |
| Net Income from farming | 526,000 | 1,272,000 |
| plus income from non-farming activities 4/ | 60,000 | 118,000 |
| Total Farm Income | 586,000 | 1,390,000 |
| Incremental Farm Income | Won 804,000 | |

1/ Excluding the cost of family labor which at present amounts to about 53% of total labor requirements. The number of man-days to be contributed by family labor at full development was assumed to remain at the present level and all increases in labor requirements to be met either through hiring additional labor or mechanization.

2/ Under present conditions, mainly taxes and public charges (won 14,000) and interest on short term loans (won 4,000).

3/ Project charges under present conditions represent the pro-rated cost of operation, maintenance and capital recovery in the partially irrigated lands.

4/ Based on country wide income projections, earning from non-farming activities were assumed to increase at 7% per year.

KOREA

YONG SAN GANG IRRIGATION PROJECT, STAGE I

Economic Rate of Return

1. The estimated useful life of the project is 50 years. When discounting the project costs and benefits over this period, the economic rate of return would be about 13%. The following assumptions were made in carrying out the analysis:

(a) Farm-gate prices for rice and barley are based upon the expected 1980 world market prices forecast, prepared by the Bank's Economics Department, and expressed in 1971 prices, cif Pusan. In the case of rice, the price was derived by using the projected price for brown rice fob USA West Coast (US$123-133 per ton) plus US$10 per ton for shipping in bulk and a conversion ratio of 1.111 to arrive at the cif price of white rice (US$137-158 per ton). The final farm gate price of US$150 per ton, used in this report, assumes that milling costs would be covered by the value of bran while port handling charges of imported rice would be equal to the transport cost from the farm to the mill. The farm-gate price adopted for barley is equal to the projected world market price of US$50 per ton fob USA West Coast plus US$10 per ton for transportation. For all other crops the farm-gate price used represents the 1965-70 annual average expressed at the 1971 price level;

(b) Project lands were assumed to be provided with an assured water supply at the following rate:

| Year | 1976 | 1977 | 1978 | Total |
|---|---|---|---|---|
| Area (ha) | 10,000 | 15,000 | 8,000 | 33,000 |

(c) Incremental benefits would start accruing in 1976 and full development reached in 1982. Following the introduction of irrigation, benefits were assumed to increase over a five-year period at the annual rate of 20%;

(d) Net value of production under the without project conditions was assumed to increase at an annual rate of 2% through 1982. This rate coincides with the country's annual increase in rice yields during 1960-1970;

(e) Farm production costs include family labor wages at the rate of W 540 per man-day of 10 hours. This rate is the average wage for males (W 650 per day) and females (W 430 per day). Costs of farm machinery include the operator's wages and amortization allowance at 10% interest;

(f) Project costs used in the economic analysis amount to US$72.3 million compared with US$85.2 million presented in Annex 5. The difference is due to the deduction of price contingencies (US$12.9 million); and

(g) Incremental annual operation and maintenance costs (US$0.7 million) are equal to expenditures after completion of project works (US$1.2 million) less present expenditures (US$0.5 million).

2. The incremental net benefits and project cost streams used in the analysis are presented below:

| Year | Project Costs | Net Value of Production | |
|---|---|---|---|
| | | Without Project | With Project |
| | US$ Million | | |
| 1 | 5.0 | 3.1 | 3.1 |
| 2 | 14.9 | 3.1 | 3.1 |
| 3 | 20.7 | 3.2 | 3.2 |
| 4 | 18.6 | 3.3 | 3.3 |
| 5 | 13.1 | 3.3 | 4.1 |
| 6 | 0.7 | 3.4 | 6.7 |
| 7 | 0.7 | 3.5 | 10.2 |
| 8 | 0.7 | 3.5 | 13.6 |
| 9 | 0.7 | 3.6 | 17.0 |
| 10 | 0.7 | 3.7 | 19.6 |
| 11-50 | 0.7 | 3.8 | 20.3 |

Rate of Return: 13.6%

Note: Project costs from the sixth year onwards represent incremental annual operation and maintenance costs.

3. Several factors, both external and internal to the project, could cause project returns to fall below the projected levels. These factors include a reduction in the rice cropped area (mainly a reflection of a shortfall in the water supply rather than the farmers' inability to attain the projected intensity level); an increase in farm production costs; an increase in project construction costs; delays in completion of project works; and a longer period being required by farmers to attain the projected benefit level. These factors were incorporated into the rate of return streams in paragraph 2 above in order to examine their impact on project benefits. The extent of deviation from the basic assumptions and the change in the rate of return are described below:

| Item | Rate of Return (%) |
|---|---|
| (a) Rice cropped area reduced by 30% | 11.9 |
| (b) Onion and garlic area reduced by 50% | 11.5 |
| (c) Farm production costs increased by 20% | 11.0 |
| (d) Construction costs increased by 30% | 10.9 |
| (e) Project construction period extended to 8 years | 12.2 |
| (f) Development period extended to 10 years | 10.8 |
| (g) Both (d) and (f) occurring simultaneously | 9.0 |

4. Three steps are necessary in calculating the project's foreign exchange benefits. First, both the foreign exchange earnings or savings and the foreign exchange costs must be determined. Second, the net foreign exchange benefits must be established by deducting the foreign exchange costs from earnings. Finally, it is necessary to determine at what cost of local resources these net foreign exchange benefits were obtained in order to decide whether the local costs are justified. Because costs and benefits take place in different years, it is necessary to express them using a common denominator. This is accomplished by presenting both in terms of their present worth, using the opportunity cost of capital as an appropriate discount rate. The ratio of discounted not local costs to discounted net foreign exchange benefits is the foreign exchange rate for the project. To evaluate this ratio, it must be compared with the prevailing foreign exchange rate for the country's currency, or, if necessary, with a shadow foreign exchange rate.

5. In calculating the project's internal foreign exchange rate, the following assumptions were made:

(a) foreign exchange earnings or savings amount to 90% of the project incremental gross value of production (US$24.8 million);

(b) foreign exchange costs are equal to 52% of total construction costs, excluding price contingencies (US$37.5 million); 30% of incremental annual operation and maintenance costs (US$0.2 million); and 40% of incremental annual farm production costs (US$4.4 million);

(c) local costs are equal to 48% of total construction costs, excluding price contingencies (W 12,876 million); 70% of incremental annual operation and maintenance costs (W 185 million); and 60% of incremental annual farm production costs (W 2,479 million); and

(d) local benefits amount to 10% of the project incremental gross value of production (W 1,036 million) and represent production which does not readily enter world trade.

6. The foreign exchange earnings and local cost streams used in the analysis are presented in Table 1. The net present worth of foreign exchange benefits to be realized over the project's life, at a discount rate of 12%, is US$44.8 million while the discounted net local costs are W 14,800 million. The ratio of the discounted costs to benefits (i.e., the internal foreign exchange rate for the project) is W 303 to the US$, which is appreciably better than the official exchange rate of W 370 per US$.

December 21, 1971

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE I

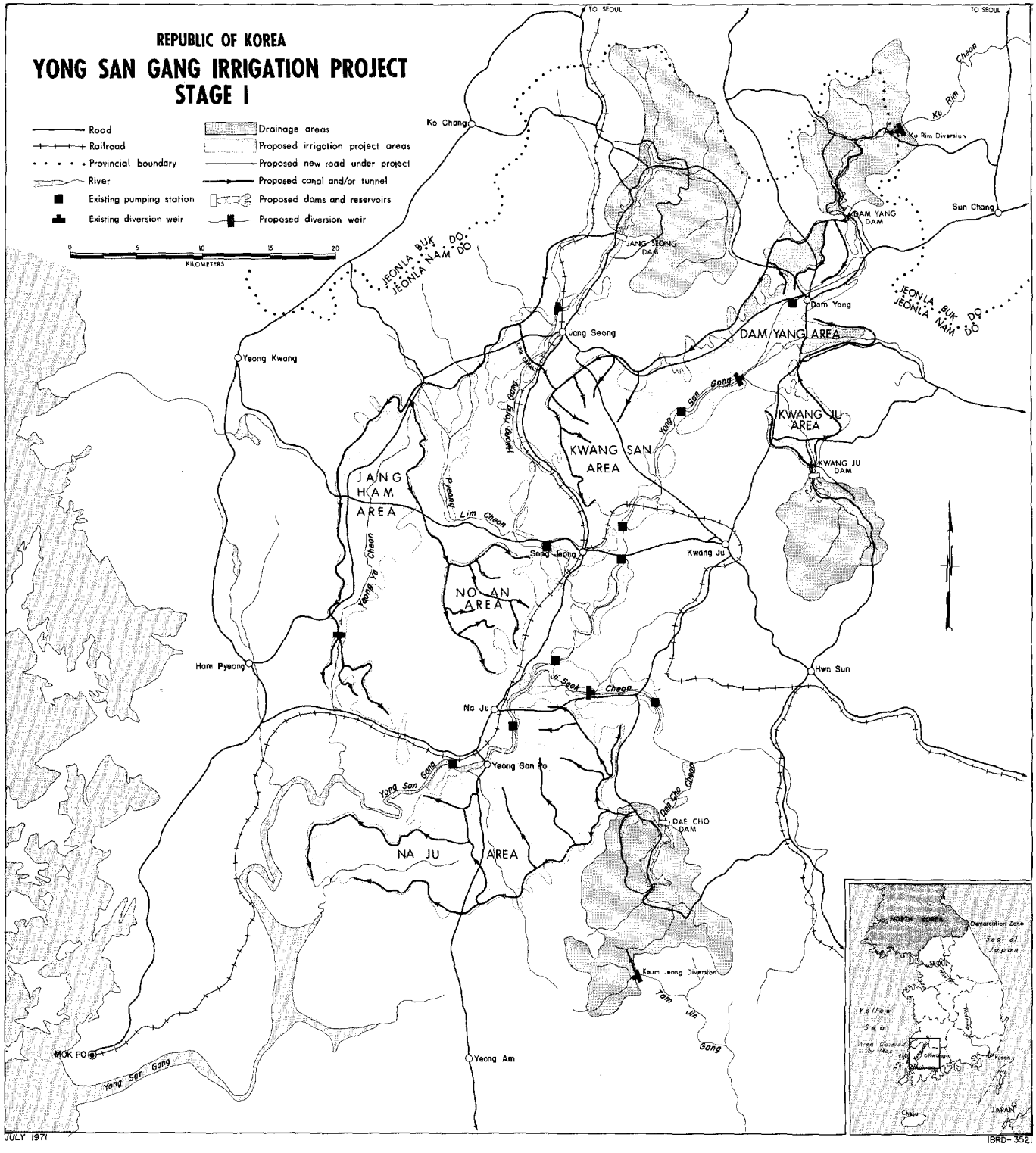
Internal Foreign Exchange Rate

| YEAR | Net Foreign Exchange Earnings 1/ | | | | | Net Local Currency Costs 2/ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Project Costs | Operation and Maintenance | Incremental Production Costs | Incremental Gross Value of Production | Net Foreign Exchange Earnings | Project Costs | Operation and Maintenance | Incremental Production Costs | Incremental Gross Value of Production | Net Local Costs |
| | US$ million | | | | | ₩ million | | | | |
| 1 | (2.6) | - | - | - | (2.6) | 925 | - | - | - | 925 |
| 2 | (7.8) | - | - | - | (7.8) | 2701 | - | - | - | 2701 |
| 3 | (10.6) | - | - | - | (10.6) | 3626 | - | - | - | 3626 |
| 4 | (9.6) | - | - | - | (9.6) | 3256 | - | - | - | 3256 |
| 5 | (6.9) | - | (0.2) | 1.3 | (5.8) | 2368 | - | 148 | (37) | 2479 |
| 6 | - | (0.2) | (0.9) | 4.9 | 3.8 | - | 185 | 481 | (222) | 444 |
| 7 | - | (0.2) | (1.7) | 9.9 | 8.0 | - | 185 | 962 | (407) | 740 |
| 8 | - | (0.2) | (2.6) | 14.9 | 12.1 | - | 185 | 1443 | (629) | 999 |
| 9 | - | (0.2) | (3.4) | 19.8 | 16.2 | - | 185 | 1924 | (814) | 1295 |
| 10 | - | (0.2) | (4.0) | 23.4 | 19.2 | - | 185 | 2257 | (962) | 1480 |
| 11-50 | - | (0.2) | (4.4) | 24.8 | 20.2 | - | 185 | 2479 | (1036) | 1628 |
| Present Worth (at 12%) | | | | | 44.8 | | | | | 14,800 |

ANNEX 14
Table 1

1/ Figures in parenthesis represent foreign exchange costs

2/ Figures in parenthesis represent local currency earnings


REPUBLIC OF KOREA
YONG SAN GANG IRRIGATION PROJECT
STAGE I
Road
Railroad
Provincial boundary
River
Existing pumping station
Existing diversion weir
Drainage areas
Proposed irrigation project areas
Proposed new road under project
Proposed canal and/or tunnel
Proposed dams and reservoirs
Proposed diversion weir
0 5 10 15 20
KILOMETERS
TO SEOUL
TO SEOUL
Ko Chang
Ku Rim Chean
Ku Rim Diversion
Sun Chang
DAM YANG DAM
JANG SEONG DAM
JEONLA BUK DO
JEONLA NAM DO
Dam Yang
DAM YANG AREA
Jang Seong
Yeong Kwang
Hwang Yong Gang
Yong Sam Gang
KWANG JU AREA
KWANG SAN AREA
KWANG JU DAM
JANG HAM AREA
Pyeong Lim Chean
Song Jeong
Kwang Ju
Yong Ya Chean
NO AN AREA
Ham Pyeong
Hwa Sun
Ji Seok Chean
Na Ju
Yeong San Po
Yong San Gang
Dae Cho Chean
DAE CHO DAM
NA JU AREA
Kaum Jeong Diversion
Tam Jin Gang
MOK PO
Yong San Gang
Yeong Am
NORTH KOREA
Demarcation Zone
Sea of Japan
SEOUL
Yellow Sea
JAPAN
JULY 1971
IBRD-3521